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NIAGARA STROMATOPOROIDS

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PREFATORY NOTE

The first of this series of articles on American Stromatoporoids was issued by the Library of the University of Toronto early in 1907, and constitutes No. 4 of the Geological Series of the University of Toronto Studies. In the above paper were described all the forms known to the writer from the Guelph dolomites of Ontario. The Guelph, while characterized by a rather distinct fauna, cannot be considered as other than the summit of the Niagaran series of formations: the present paper, therefore, forms a natural sequence to that already issued.

While the Guelph examples are almost always very poorly preserved, a great variation in this respect is shown by the Niagara forms. Silicified specimens of *Clathrodictyon vesiculosum* from Lake Temiskaming present the acme of perfection, while the vast majority of examples, silicified or otherwise, from Kentucky are practically beyond recognition. The same may be said for most of the specimens from Manitoulin Island, while those from farther west—Drummond Island and northern Michigan—show the details of structure in a much more satisfactory manner. Of the unsilicified specimens, the best I have seen are those collected in the middle States and belonging to the United States National Museum. The structure of specimens in the natural condition from Hamilton, Ontario, is almost indeterminable, owing to interstitial crystallization.

Niagara rocks are of wide distribution, but the literature of their fauna is singularly devoid of reference to this class of organism. It is to be regretted that access to specimens from more localities was not possible; nevertheless the present notes are founded on extensive collections from typical and widely separated regions. The more important series examined are as follows:—

From Mann Island, Lake Temiskaming, and the Blanche river north of that lake—collected by the author.

From Assiginack and Tehkummah, Manitoulin Island—collected by Mr. Joseph Townsend for the University Museum.

From Hamilton, Ontario—collected by Mr. Townsend or presented by Col. C. C. Grant, of Hamilton.

From Drummond Island and northern Michigan—lent by the United States National Museum.

From Louisville, Ky.—purchased from G. K. Greene, of New Albany, Ind.

From various localities in the middle States—lent by the United States National Museum.

From various localities—presented by Dr. B. E. Walker, of Toronto.

From Michigan—lent by Dr. A. C. Lane.

From the Albany river region, Ontario—lent by the Geological Survey of Canada.

While a number of new species have been described from these various collections, it must be admitted that many more will ultimately be found, as probably two-thirds of the material examined is in too poor a state of preservation to justify any attempt at description. Among these unsatisfactory specimens, however, were seen examples showing, by surface characters or otherwise, evidences of belonging to different species. It is to be hoped that better representatives of these may be found and described. I believe that the present list will eventually be considerably extended.

It is fitting to refer to the work of Dr. Carl Rominger, who collected and worked up a large part of the material in the United States National Museum. I have had the advantage of his labels, and have, as far as possible, adopted his specific names. As Rominger's work was done before the appearance of Nicholson's monograph, his generic differentiation appears to have been confined to *Stromatopora* and *Labechia*. Unfortunately, Dr. Rominger's work has not been published, except incidentally in the article referred to below, which appeared in the Proceedings of the Academy of Natural Sciences of Philadelphia.

To Dr. Richard Rathbun and to Dr. Ray S. Bassler, of the United States National Museum, the author wishes to express his obligations for permission to examine their extensive collections, without which this paper would have lost much in scope; in fact, would have been largely confined to Canadian species. To Dr. Bassler I am also indebted for the determination of *Ceramoporella irregularis*. My thanks are likewise expressed to Dr. J. F. Whiteaves, of the Geological Survey of Canada, and to Dr. A. C. Lane, of the Geological Survey of Michigan, for their courtesy in the loan of material for study.

W. A. PARKS

UNIVERSITY OF TORONTO
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NIAGARA STROMATOPOROIDS

The literature referring to the Niagara Stromatoporoids is rather meagre and is scattered over many different publications. The following list includes the more important articles in the order of their appearance. Reference is also made to papers dealing with Niagara fauna in which no Stromatoporoids are listed.

1851—Professor James Hall, in the second volume of the "Palaeontology of New York," makes the first reference to Niagara Stromatoporoids. *Stromatopora concentrica*, Gold., is stated to occur in the rocks of the State and a new species, *S. constellata*, is described and figured.

1863—The Report of Progress of the Geological Survey of Canada for this year gives *Stromatopora concentrica* in the list of fossils from the Niagara of Lake Temiskaming and Manitoulin Island.

1865—Winchell and Marcy recognize no Stromatoporoids in the fauna of Waldron, Ind. (Vol. I., No. 1, Proceedings of the Boston Society of Natural History.)

1866—Billings recognises *Stromatopora concentrica* in the rocks on the west side of Lake Manitou, Ont. (Report. Geol. Sur. Can. 1863-66, p. 176.)

1873—Dr. Rominger states that these forms occur in different places in the State of Michigan. He also expresses the intention of describing two new species, *Stromatopora minuta* and *S. vesiculosa*. (First Report, Geological Survey of Michigan.)

1874—In an article on the Niagara fauna of Clark and Floyd counties, Ind., no mention is made of Stromatopora. (Fifth Report, Indiana Geol. Sur.)

1874—The first reference to *Stromatopora hindei*, Nich., appeared in this year. (Ann. Mag. Nat. Hist., January.)

1875—In the "Palaeontology of the Province of Ontario," Nicholson mentions *Stromatopora striatella*, d'Orb., as "common at Thorold and rare at Rockwood, Ont." He also gives a lengthy description, with figures, of *S. hindei*.

1875—Nicholson describes *Dictyostroma undulata* from the Niagara of Louisville, Ky. (Palaeontology of Ohio, Vol. II.)

1876—No Stromatoporoids are mentioned in a report on the Niagara of Huntington Co., Ind. (Seventh Report, Indiana Geol. Sur.)

1877—T. C. Chamberlin (Vol. II, Wisconsin Geol. Sur. Reports) mentions *S. concentrica* in the Maysville beds (p. 340), in the lower coral bed (p. 350), and in the upper coral beds (p. 352). He also states that a Stromatoporoid of undetermined species occurs in the Racine beds (p. 372).

1878—Nicholson and Murie describe *Clathrodictyon vesiculosum* and *Pachystroma antiqua* in the Journal of the Linnaean Society.

1879—Dr. J. M. Dawson, in the Quarterly Journal of the Geological Society, contributes an article on "The Microscopic Structure of Stromatoporidae, etc." The following species are recognized in the Niagara: *Stromatopora concentrica*, Gold.; *Coenostroma constellatum*, Hall: *Dictyostroma undulatum*, Nich.; and *Caunopora hudsonica*, n. sp. The new species is described from a specimen collected by Dr. Robert Bell on the Albany river, Ont. The description is accompanied by two plates.

1882—A list of Niagara fossils is given in the Eleventh Report of the Geological Survey of Indiana, but no mention is made of *Stromatopora* from Shelby or Delaware counties, or from Waldron.

1882—In the same year Whitfield makes no mention of these forms in his list of Niagara fossils in volume IV of the Reports of the Geological Survey of Wisconsin.

1883—*Stromatopora concentrica* is stated to occur at Jay City and in Decatur county, Ind., in the Twelfth Report of the Survey.

1883—In volume X, No. 3, of the Canadian Naturalist, Dr. J. W. Spencer gives a list of Canadian Niagara fossils, including the following Stromatoporoids: *Stromatopora concentrica*, Gold.; *Caunopora walkeri*, Spencer; *Caunopora mirabilis*, Spencer; *Coenostoma constellatum*, Hall; *Coenostoma botryoideia*, Spencer; *Dictyostoma reticulata*, Spencer; and *Stromatopora hindei*, Nich.

1884—In the article above cited Spencer refers to the description of his species as having appeared in 1882. He must refer to advance sheets, for the actual publication referred to bears the date 1884. The article is entitled the "*Stromatoporidae* of the Upper Silurian," and appears as part of a Bulletin of the Museum of the University of Missouri. Professor Spencer here gives the same list quoted above, with descriptions and figures of his new species. *Coenostoma restigouchense*, Spencer, is also described, but it is not strictly a Niagara species, the type specimen having been collected from the Lower Helderberg beds at Dalhousie, N.B. In a footnote *Caunopora hudsonica*, Dawson, is referred to.

1884—No Stromatoporoids are mentioned in a list of Niagara fossils from Grant county, Ind. (Thirteenth Report, Indiana Survey.)

1885—Dr. R. W. Ells states that *Stromatopora concentrica* (?) occurs on the Scaumenac river in Gaspé. (Report, Geol. Sur. Can. 1882-83-84.)

1886—In this year an important contribution to the literature of Stromatoporoids appeared in the Proceedings of the Academy of Natural Sciences of Philadelphia. The author, Dr. C. Rominger, attacks the position taken by Nicholson and Murie with regard to the general affinities of the group, and is inclined to disallow several of their genera. As the discussion is centred around Niagara examples it is particularly interesting in the present connection. Rominger considers the genus *Pachystroma*, established by Nicholson and Murie on examples from the Niagara limestone at Lockport, to be identical with *Stromatopora*. Professor Rominger also objects to the genus *Clathrodictyon*, thinking it to be indistinguishable from *Stromatopora*. The genus *Dictyostroma* described by the authors from the Niagara of Kentucky is thought by Rominger to be allied to *Alveolites* or *Limaria*. In this paper Professor Rominger refers to a manuscript in which several Niagara forms are figured and described. It is to be regretted that this work has never appeared. In reading his article one is impressed by the fact that Rominger had not seen Nicholson's monograph, the first part of which was issued shortly afterwards.

1887—*Clathrodictyon vesiculosum*, Nich. and Murie, is redescribed by Nicholson in the Annals and Magazine of Natural History for January. *C. fastigiatum* is also described and figured, although Nicholson does not state that it occurs in America.

1888—In the first number of the American Geologist, Ringueberg gives a list of Niagara fossils from the shales of western New York, but makes no mention of Stromatoporoids.

1891—Nicholson describes *Stromatopora antiqua* in the Annals and Magazine of Natural History for April.

1892—Various parts of the Monograph on British Stromatoporoids appeared between the years 1886 and 1892; the title-page, however, bears the date 1892, and it is considered best to list the volume here. In this classic work Nicholson has said the final word as to the affinities and classification of Stromatoporoids; it must remain our standard until a revision of the whole subject is published by a competent observer. With regard to Niagara forms the monograph refers to *Clathrodictyon fastigiatum*, *C. vesiculosum* and *Stromatopora hudsonica*. Spencer's species are mentioned in the introductory discussion, the genus *Pachystroma* is abandoned, and doubt is expressed as to the validity of *Dictyostroma*. In the appendix the author accepts the view that *Dictyostroma* is not referable to the Stromatoporoids, but no mention is made of Rominger's previous conclusion to this effect.

1893—Mr. J. B. Tyrrell states that *Stromatopora sp.* is found in the Niagara limestone of north-west Manitoba. (Geol. Sur. Can., Vol. V, p. 202E.)

1893—Mr. Hugh Fletcher gives a list of Niagara fossils, but mentions no Stromatoporoids. (Report on Pictou and Colchester, N.S.—Geol. Sur. Can., Vol. V.)

1896—In an article on Canadian Stromatoporoids in the July number of the Canadian Record of Science, Dr. J. F. Whiteaves gives the following list from the Niagara: *Clathrodictyon vesiculosum*, *Stromatopora antiqua*, *Stromatopora constellata*, *Stromatopora hudsonica* (Niagara?), *Stromatopora nindei*, *Stromatopora striatella*, *Caunopora walkeri*, *Caunopora mirabilis*, *Coenostroma botryoideum* and *Dictyostroma reticulatum*.

1897—No mention is made of Niagara Stromatoporoids in a list of fossils from that horizon in the Twenty-second Report of the Geological Survey of Indiana.

1899—Dr. A. H. Ami refers to *Clathrodictyon vesiculosum* as occurring in large masses on Lake Temiskaming. (Vol. X, Geol. Sur. Can., p. 291 I.)

1904—In a list of Upper Silurian fossils from Keewatin, Dr. Whiteaves states, "*Stromatoporoidea*, genera and species undetermined." (Preliminary List of Fossils from the Equan river and Sutton Mill lakes, Keewatin—Geol. Sur. Can.)

1906—Dr. Whiteaves mentions an undetermined Stromatoporoid from the Upper Silurian rocks of Keewatin (Pal. Fos. Vol. III, Pt. 4, p. 241), also an undetermined species on page 276 of the same volume.

1906—Dr. H. M. Ami records the occurrence of a new species, *Clathrodictyon* (?) *franklinense*, on Beechey Island, Lancaster Sound, and gives the following species from Southampton Island: *Clathrodictyon regulare*, *C fastigiatum*, *C.* sp., cf. *striatellum*, and *C.* (?) *crassum*. (Low, *Report on the Dominion Government expedition to Hudson Bay*, etc. Ottawa: Government Printing Bureau.)

ORDER—STROMATOPOROIDEA, *Nicholson and Murie*

Section A. (Hydractinoid Group)

Family—ACTINOSTROMIDAE, *Nich.*

Genus—ACTINOSTROMA, *Nich. and Murie*

ACTINOSTROMA TENUIFILATUM, *sp. nov.*—Plate IX, Figs. 1, 2, 3

STROMATOPORA TENUIFILATA, *Rom.* MSS.

Size and shape of coenosteum unknown, but it must have been at least 5 cm. thick, and probably had the form of a circular expansion of 15 cm. diameter.

An examination of the minute structure shows concentric laminae and continuous radial pillars, both of extreme tenuity. Of the laminae, from eight to ten occur in the space of 1 mm., but they are not uniformly spaced, being somewhat crowded together for a variable distance and then being marked by a wider interspace. This feature is, however, by no means constant. The pillars are of about the same calibre as the laminae, and, although varying considerably, average a slightly greater distance apart. Astrorhizae are apparently absent.

Vertical sections (Plate IX, fig. 1) show the laminae and pillars as above described, and give the effect of a rectilinear network. No rounded meshes for astrorhizal canals were observed.

Tangential sections (Plate IX, fig. 2) show the cut ends of the radial pillars as round dots with a somewhat stellate appearance. Where the laminae are intersected these latter elements appear merely as darker portions of the section, the connecting whorls of arms being obscured by mineralization. As the species conforms so exactly to the typical *Actinostroma* there can be no doubt that the connecting arms exist, in fact they are faintly shown in the stellate character of the cross sections of the pillars.

A somewhat coarser example, with an average of seven laminae to the mm., is shown in Plate IX, fig. 3. The pillars are also correspondingly far apart. As there is no structural difference except this coarser character of the reticulation, it is thought better to include both forms under the one species.

Observations.—This species comes closer to *Actinostroma intertextum* than to any other representative of the genus, but it is easily distinguished by the regularity and continuity of the laminae. The coarser type resembles *Actinostroma vulcanum*, Parks, in the character of the reticulation, but none of the peculiar structures to which the latter species owes its name were observed. It must be admitted, however, that many examples of the Guelph *Actinostroma* are likewise without the "volcanoes," and might just as well be referred to this species.

Locality.—Drift of Ann Arbor, Mich., U.S.N.M., No 36829, Dr. C. Rominger, coll.; Drummond Island, U.S.N.M., No. 36828, C. Rominger, coll.; Pagwachuan river, Canad., Geol. Sur. Can.

ACTINOSTROMA INFLECTUM, *sp. nov.*

A form closely related to *A. tenuifilatum*, but with the laminae bent into sharp folds, occurs in some abundance over the Silurian area west of Hudson Bay. A preliminary description will appear in the *Ottawa Naturalist* for April, 1908, but as this region is not yet strictly relegated to the Niagara, it is better, so far as this series is concerned, to reserve the description for a later number.

ACTINOSTROMA WHITEAVESII, *var.* NIAGARENSE, *var. nov.*—Plate XII, Figs. 4 and 5

ACTINOSTROMA WHITEAVESII, *Nich.*, Ann. and Mag. Nat. Hist., p. 320, pl. ix, figs. 3 and 4, April, 1891

The finding of a specimen of this species in the Niagara of Ontario is very remarkable in view of the fact that it was first described from the Devonian of the Little Red River. There is no doubt as to the horizon of my specimen, as it is associated with other Niagara forms and is from the collection of Dr. B. E. Walker and bears his label. There is no doubt either as to the identity of the species, for it has peculiar and well marked characteristics. In fact, so close an analogy is presented to Nicholson's species that it is difficult to find points of dissimilarity on which to found a new variety. The difference in geological horizon, however, makes it advisable to distinguish this form by a separate name. Nicholson's description (*op. cit.*) follows:—

"The coenosteum in this species is massive and hemispherical in form, with an imperfect latilaminar structure. The skeletal laminae are undulated in such a manner as to give rise to low and broad prominences, which are placed about eight mm. apart. These eminences represent the points where the astrorhizae open on the surface; but these structures are peculiar in so far that they are entirely circumscribed and do not appear to send out any radial, horizontal branches. Each astrorhiza, in fact, consists simply of a group of short vertical canals, of larger calibre than the ordinary zooidal tubes, which open in a rosette-like cluster at the summit of the eminences above spoken of, the canal-apertures often having a distinctly radial arrangement.

"In microscopic structure *A. whiteavesii* is a typical *Actinostroma*, the coenosteum consisting of parallel radial pillars united at corresponding levels by whorls of connecting processes or 'arms.' As seen in vertical sections the radial pillars are of moderate thickness, about ten occupying the space of two mm., measured transversely, while the whorls of connecting processes (forming the 'concentric laminae') are decidedly more distant, about seven only of these structures being present in the same space measured vertically.

"In tangential sections the rounded ends of the transversely divided radial pillars are seen to be united by very regularly developed whorls of connecting processes, the thickness of which is very nearly equal to the diameter of the radial pillars themselves. The result of this is that the tangential sections coinciding with the plane of the laminae show a characteristic areolated structure, which is not at all unlike that exhibited by corresponding sections of some Monticuliporoids.

. . . .

"Though, as just stated, *A. whiteavesii* has a general resemblance to *C. expansum*, Hall and Whitf., it is at once distinguished from this by the much finer structure of the skeleton, and also by the exceptional relative thickness and very regular development of the connecting processes of the radial pillars. The areolated aspect of tangential sections resulting from the characters last mentioned is indeed the essential peculiarity of *A. whiteavesii.* Another very characteristic feature, by which the species is distinguished from allied forms, is the reduction of the astrorhizae to their vertical canals only, and the arrangement of the apertures of these in more or less definite rosette like groups.

"*Locality and Formation.*—Devonian, Little Red River, Canada (coll. Geol. Sur. Canada)."

The surface characters of the present specimen are not observable, as it is intergrown with *Favosites gothlandica* and *Alveolites thoroldensis;* its minute structure is, however, strikingly like that of Nicholson's species. In vertical sections (Plate XII, fig. 4) the delicate vertical pillars are the most pronounced element; they are so spaced that about seven occur in a millimetre. That these vertical lines represent pillars and not the cut walls of tubes is shown by the fact that they die out instead of running together when cut obliquely. The horizontal laminae, when viewed with a hand lens of low power, are seen to be continuous and of greater calibre than the pillars. Higher powers, however, reveal the fact that they are really formed from the pillars, as they are often slightly bent between a pair of these structures. The "indistinct latilaminar structure" may be observed in a crowding of the laminae at certain levels and their less perfect development when so placed. In tangential section (Pl. XII, fig. 5) the appearance is so like that of certain *Bryozoa* that I had nearly passed the specimen over as such until my attention was arrested by the "rosettes." The areolated appearance is clearly shown, and when the section is interlaminar the cut ends of the pillars may be seen, but very indistinctly.

Observations.—The similarity to *A. whiteavesii* is at once apparent, the differences being chiefly the following:—the pillars and laminae are more closely set and in consequence the whole reticulation is finer; there is no evidence of the laminae being bent into folds so that the astrorhizal system may open at their summits. The very peculiar character of the connecting "arms" and the occurrence of the unique astrorhizae make it impossible to separate this example from *A. whiteavesii;* the different horizon, and the minute differences stated above, seem, however, to justify the creation of a new variety.

Locality.—Thorold, Ont. University of Toronto Museum.

Actinostroma matutinum, *Nicholson*

This form was described by Nicholson from L'Anse au Gascon, Baie de Chaleur. Together with other species of probable Niagara age it will be reviewed in a later number of this series.

Genus—CLATHRODICTYON, *Nich. and Murie*

The Niagara formation is particularly rich in representatives of this genus, the various species of which show so many varieties and transitional stages that great difficulty is found in identifying any given specimen. One might readily differentiate more species than are here described, but it has been considered advisable to make as few specific names as possible and to include in one species a number of varieties, although these varieties are not individually considered as such. The Niagara Clathrodictyons fall into three groups which are clearly defined and are given the name of the predominating species.

Group of Clathrodictyon vesiculosum
Clathrodictyon vesiculosum, *Nich. and Murie*
Clathrodictyon vesiculosum minutum, *var. nov.*
Clathrodictyon vesiculosum astro-distans, *var. nov.*
Clathrodictyon variolare, *von Rosen*

Clathrodictyon vesiculosum, *Nich. and Murie*.—Plate VII, Figs. 1 and 6; Plate VIII, Figs 2, 4 and 5

Stromatopora striatella, *McCoy*, Brit. Pal. Foss., p. 12, 1851.
Clathrodictyon vesiculosum, *Nich. and Murie*, Jour. Linn. Soc. Zool., vol. xiv, p. 220, pl ii, figs. 11-13, 1878.
Clathrodictyon vesiculosum, *Nich. and R. Etheridge, jr.*, Mon. Sil. Foss. Girvan, p. 238, pl. xix, fig. 2, 1880
Stromatopora concentrica, *Spencer*, Bull. Mus. Univ. Missouri, vol. i, no. 1, p. 45, 1882.
Stromatopora minuta, *Rominger*, Proc. Acad. Nat. Sci. Phil., p. 40, 1886.
Clathrodictyon vesiculosum, *Nich.*, Ann. Nat Hist., ser. 5, vol. xix, p. 1, figs 1-3, 1877.
Clathrodictyon vesiculosum, *Nich.*, Mon. Brit. Strom., p. 147, pl. xvii, figs. 10-13, and pl. xviii, fig. 12, 1892.
Clathrodictyon vesiculosum, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 134, 1896.

Owing to the importance of this species it is thought best to give Nicholson's description in full, as follows:—

"The coenosteum in this species is in the form of a laminar expansion, having the lower surface covered with a concentrically striated or wrinkled epitheca, and attached at one point to some foreign body. Adult specimens grow to a size of half a foot or more in diameter, with a thickness in the centre of an inch or more. The upper surface is irregularly undulating, without 'mamelons,' and exfoliating concentrically round the elevated points. Small but well developed astrorhizae, the centres of which are from 3 to 5 mm. apart, are present: but the central canals of these do not open on the surface by prominent apertures.

"As regards internal structure, the coenosteum is made up of closely concentric laminae, which are only slightly or not at all undulated, and of which from nine to eleven in general occupy the space of one mm. The laminae are minutely crumpled, so as to give rise to more or less perfect radial pillars; but these structures are invariably confined to their respective interlaminar spaces, and are, therefore, not 'continuous.' In this way the interlaminar spaces become broken up into minute, often imperfect, lenticular cells (Plate VII, figs. 1 and 6; Plate VIII, fig. 2), which are formed by the curved inflections of the concentric laminae conjoined with the more or less incomplete radial pillars. In general, from eight to ten interlaminar spaces occupy the space of one mm. The cells formed by the radial pillars or by the bendings of the laminae are very variable in size, but are mostly from one-eighth to one-tenth mm. in length.

"*Obs.—C. vesiculosum* is the type-species of the genus *Clathrodictyon*, Nich. and Murie. As in all the species of the genus, therefore, the radial elements of the skeleton are incompletely developed, and never extend from one interlaminar space into adjoining ones. While the radial pillars are thus imperfect, the concentric laminae of the coenosteum are minutely undulated, and the interlaminar spaces thus become broken up and subdivided into vesicles, the size and shape of which are exceedingly variable. Hence vertical sections of *C. vesiculosum* (Plate VII, figs. 2 and 6; Plate VIII, fig. 2) show a minutely vesicular structure, the coenosteum appearing to be made up of exceedingly small lenticular cells, arranged in horizontal or slightly curved rows. On the other hand, tangential sections (Plate

VIII, figs. 4 and 5) show the cut ends of the isolated and imperfect radial pillars, together with the irregularly divided edges of the concentric laminae. The radial pillars, as seen in tangential sections, show no traces of radiating 'arms' or connecting processes, but they may sometimes become conjoined in short vermiculate rows. Small astrorhizae are seen in tangential sections, and these usually are arranged in vertical groups, and have wall-less axial canals, but the openings of the latter on the surface are not prominently elevated.

"*C. vesiculosum*, Nich. and Mur., belongs to a series of forms, the specific determination of which is exceptionally difficult. The forms in question, viz. *C. vesiculosum*, Nich. and Mur., *C. variolare*, Rosen sp., *C. linnarssoni*, Nich., and *C. crassum*, Nich., are all easily recognized as distinct when typical examples are selected for examination. It is, therefore, expedient to distinguish them by separate specific names. At the same time, there are close relationships between all these forms, and examples are not uncommon which show intermediate or transitional characters, and which, therefore, it is difficult to refer definitely to any one of the four. In a less striking form, a passage may also be traced between this group of types and *C. fastigiatum*, Nich.

"From all of the allied forms above mentioned, *C. vesiculosum* is best distinguished by the extreme closeness with which the concentric laminae are set, and the resulting minuteness of the cells which compose the coenosteum. Not only are the laminae exceedingly close, but the interlaminar spaces are nearly equal in width, and the cellular tissue of the skeleton is thus approximately uniform. On the other hand, in typical examples of *C. variolare*, Rosen sp., the interlaminar spaces are unequal in size, wide spaces alternating tolerably regularly with spaces which are much narrower than the average, and which are usually arranged in groups (Plate VII, fig. 4). Trivial as this difference is, it is one which gives a very different aspect to vertical sections of these two forms. In other examples of *C. variolare*, in which this alternation of wide and narrow interlaminar spaces is not so marked, all the interlaminar spaces are wider and the cellular structure is coarser than in the present species. In *C. linnarssoni*, Nich., again, the concentric laminae are much less crumpled, and the cells of the interlaminar spaces are, therefore, much more nearly quadrangular than is the case in *C. vesiculosum.* The form which I have named *C. crassum* is sufficiently distinguished from the present species—when characteristic examples of the two are compared with one another—by the comparatively small number of concentric laminae in a given space, and by the much thicker and coarser structure of the skeleton-fibre. Lastly, *C. fastigiatum*, Nich., is in general readily separated from *C. vesiculosum* by the much greater width of the interlaminar spaces and the chevron-like foldings of the concentric laminae.

"*Distribution.*—*Clathrodictyon vesiculosum*, so far as known, is exclusively confined to the Silurian rocks, and is especially characteristic of the lower portion of the Silurian (May Hill and Wenlock zones). In strata of this age the species has, in fact, an extraordinarily wide range. In England, *C. vesiculosum* is of comparatively common occurrence in the Wenlock Limestone, and I have collected examples of it at Much Wenlock, Dudley, Ironbridge, and Dormington. In Scotland it has been collected by Mrs. Robert Gray in the Silurian rocks (Woodland-beds) of Woodland Point, near Girvan. In North America the species seems to be abundant in the Clinton and Niagara formations, and I have personally collected examples in the Clinton beds of Yellowsprings, Ohio, and the Niagara Limestone of Canada (Thorold). By the kindness of Mr. Whiteaves I have also recently had submitted to me examples of this species collected by the Geological Survey of Canada in the Clinton formation of Anticosti (Junction Cliff and west side of Gamache Bay). I have, further, collected examples of this species in the Silurian Limestones of Esthonia in the 'Zone of Pentamerus esthonus' at Kattentack, and in the 'Raikull-beds' at Raikull. The prevailing species of Clathrodictyon in the Silurian rocks of Esthonia is, however, not the present form, but *C. variolare*, Rosen, and I have not seen any examples of this species from Gotland, though I entertain no doubt of its occurrence there."

Precisely the same difficulty experienced by Nicholson in distinguishing the European forms of these fine-grained Clathrodictyons is encountered in the American examples. The Niagara formation presents three clearly defined types, while many intermediate varieties occur. First there is the normal *C. vesiculosum*, as above described; second, a species with straight laminae and distinct pillars which might be compared with *C. linnarssoni;* third, a type with occasional coarser vesicles apparently identical with *C. variolare*, Rosen.

Dr. Rominger seems to have been familiar with some of the variations of this species, for he refers to *C. variolare* as "A monticulose variety of *C. minutum*" (U.S.N.M. label). This latter specific name was made by Rominger to include all the varieties, although he eventually discarded it for Nicholson and Murie's name. Although the majority of specimens present the aspect of a laminar expansion, the general shape of the coenosteum is by no means confined to this form alone. Globose and hemispheric examples are common, and many specimens were examined of which the shape conforms closely to that figured for *S. antiqua* (Plate XIII, fig. 4). This is a common form at Louisville, Ky., where the specimens are about 5 mm. in diameter by 10 or 15 in height. The various differences, on which varieties or even species might be founded are expressed in the degree of crumpling of the laminae and in the distinctness of the radial pillars as individual structures. The common or typical aspect is shown in Plate VII, fig. 1, where the lenticular interspaces are clearly shown. The radial pillars are evidently derived from flexures of the laminae. A tangential section of this type is exhibited in Plate VIII, fig. 4. Through a reduction in the degree of crumpling of the laminae a whole series of forms arise, and this reduction finds its culmination in almost straight horizontal laminae and clearly defined radial pillars. Of this extreme variety a vertical section is shown in Plate VII, fig. 6, and a tangential in Plate VIII, fig. 5. In this latter figure the greater distinctness of the cut ends of the pillars may be observed. The darker bands indicate the laminae, as, owing to the globose character of the coenosteum, a continuous interlaminar section is impossible. This variety approaches close to *C. linnarssoni*, Nich., but as Nicholson's genotype, figured on Plate V, fig. 5, of his monograph, is not far from this straight type, and as so many intermediate forms are found, it is better to retain it in the same species, but for convenience of reference and to perpetuate Rominger's name it might well be designated as var. *minutum*.

Not only do varieties occur showing, throughout the coenosteum, a degree of crumpling intermediate between the two forms mentioned, but in the same example both straight and crumpled laminae may occur (Pl. VIII, fig. 2).

Although the size and distribution of astrorhizae is not to be considered of specific importance, I have seen one specimen (U.S.N.M., No. 36925) in which the astrorhizae are so large and so far apart as to be particularly noticeable. Whereas in typical examples of *C. vesiculosum* these structures are distant from each other from three to five millimetres, in this specimen they are separated by twice that interval. Dr. Rominger has labelled this specimen "*Clathrodictyon constellatum*, Hall," but has appended a note, "I can see no difference in its structure from *Clathrodictyon minutum*, Rom." The pillars also seem wider spaced and the general structure very like *C. linnarssoni.* I propose for this variety the name *C. vesiculosum* var. *astrodistans.*

Locality—Widespread in the Niagara and Clinton formations, but I have not met with examples in the upper part of the former series. Lake Temiskaming, Hamilton and Grimsby, Ont., Manitoulin Island, Forks of the Credit, Ont., Severn river, Hudson Bay, Drummond Island, Northern Michigan, Drift of Ann Arbor, Anticosti, New York, Iowa, Ohio, Kentucky, Indiana, etc. *C. vesiculosum* may also occur in the Medina, as it has been found in the "passage beds" from the Clinton into the Medina near Hamilton, Ont.

CLATHRODICTYON VARIOLARE, *von Rosen sp.*—Plate VII, Fig. 2; Plate VIII, Figs. 1 and 9.

STROMATOPORA VARIOLARIS, *von Rosen*, Ueber die Natur der Stromatoporen, p. 61, pl. ii, figs. 2-5, 1867.
CLATHRODICTYON VARIOLARE, *Nich.*, Ann. Mag. Nat. Hist., ser. 5, vol. xix, p. 4, pl. i, figs. 4-6, 1887.
CLATHRODICTYON VARIOLARE, *Nich.*, Mon. Brit. Strom., p. 150, pl. xviii, figs 1-5, pl. xvii, fig. 14, 1892.
CLATHRODICTYON VARIOLARE, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 130, 1897.

Nicholson's description is as follows:—"The coenosteum in this species is laminar, hemispherical or massive, with a concentrically wrinkled basal epitheca, and often attaining a large size. The surface may be smooth or may exhibit numerous mamelons, which are sometimes small and pointed, but more commonly low and rounded (Pl. VIII, fig. 9). There are numerous astrorhizae, but these are small in point of size, and do not appear to correspond in any way with the surface eminences or 'mamelons,' when these latter structures are present. Generally the astrorhizae are arranged in vertical groups or systems, each group having a wall-less axial canal, but this arrangement does not appear to be constant.

"The internal structure of *C. variolare* is very similar to that of *C. vesiculosum*, the skeleton being composed of close-set concentric laminae, which are horizontal, or, more usually, gently undulating, and are minutely crumpled, so as to give rise, along with the incomplete radial pillars, to a fine vesicular tissue. From eight to ten laminae occupy the space of one mm.: but the interlaminar spaces are of unequal size, rows of large vesicles alternating with rows of much smaller cells. As a rule, rows of large vesicles are separated by from one to three rows of much more minute vesicles; but there may be only a single row of the latter, or they may even be wanting in places. Tangential sections show the cut ends of the irregular radial pillars and the divided edges of the crumpled laminae, but no characteristic features. The radial pillars, especially in the rows of large cells, are very commonly imperfect, thus allowing contiguous cells to communicate freely with each other..........I have not, however, met with any examples of it in the Clinton and Niagara formations of North America, where *C. vesiculosum* is very abundant."

If *C. variolare* is really distinct from *C. vesiculosum* it certainly occurs in the Niagara of North America. Many examples are found in which the rows of large vesicles, which Nicholson makes the crucial test, are clearly shown, so clearly that on vertical weathered surfaces distinct depressions are formed giving the exterior effect of latilaminae. In all examples that I have examined the presence of mamelons is a characteristic feature; as *C. vesiculosum* never shows these structures, we have here an easy means of distinguishing the species. It must be remembered that Nicholson states these eminences to be sometimes wanting, but as far as my observations go this exception does not hold for American specimens. The mamelons are low and round and are from 3 to 5 mm. apart (Pl. VIII, fig. 9).

Vertical sections of American examples show clearly the structure described above. Plate I, fig. 2, is prepared from a specimen from Manitoulin Island and Plate VIII, fig. 1, is from United States National Museum, specimen no. 36825, obtained by Rominger from the north shore of Lake Michigan. Tangential sections show no diagnostic features.

Locality.—Mann Island, Lake Temiskaming, Manitoulin Island, Drummond Island and the north shore of Lake Michigan. Specimen no. 36919 of the United States National Museum is from Drummond Island and has been labelled by Dr. Rominger, "*Stromatopora minuta*, monticulose variety." According to Dr. Whiteaves (*op. cit.*) *C. variolare* is also found in the Hudson River formation, at the Jumpers, Anticosti, and at Cape Smyth, Lake Huron. Through the kindness of Dr. Whiteaves I have had the opportunity of examining a specimen from the Equan river, in northern Canada, which apparently belongs to this species.

Group of CLATHRODICTYON CYSTOSUM

CLATHRODICTYON CYSTOSUM, *Rominger*
CLATHRODICTYON CYSTOSUM, *var.* LINEATUM, *var. nov.*
CLATHRODICTYON CYSTOSUM, folded variety passing into
CLATHRODICTYON FASTIGIATUM, *Nich.*

CLATHRODICTYON CYSTOSUM, *Rominger sp.*—Plate I, Figs. 2, 3, 4; Plate VIII, Figs. 6 and 8.

STROMATOPORA VESICULOSA, *Rom.*, Proc. Acad. Nat. Sci. Phil., p. 50, 1886.
STROMATOPORA CYSTOSA, *Rom.* MSS. (Labels, U.S.N.M.)

As in the case of *C. vesiculosum* there are found throughout the Niagara a series of forms, which are distinct in typical examples, but which pass by insensible gradation into one another. Dr. Rominger had evidently been impressed by these types, for he says (*op. cit.*): "Associated with this form (*C. vesiculosum*, Nich.) are several other forms of much coarser structure with from six to eight laminae within the space of one line, which exhibit the Clathrodictyon structure in much more ideal perfection than the form does. These had been described in my before mentioned essay under the name of *Stromatopora vesiculosa*, as their vertical sections appear as an accumulation of layers of cystose cells, rather than as a succession of continuous laminae, separated by interstitial spaces. The demarking walls of the cells appear in vertical sections as the meshes of a network bounded by lines diagonally intersecting the direction which the laminae should have if they formed continuous leaves. In some of these specimens a banded structure is observable, whereby from five to eight layers of vesicles are grouped together to form a broader band, which is then sharply defined by a straight continuous division line from the adjoining similar bands above and below it." As the name *vesiculosum* has been used for the species already described it cannot be used here. Rominger himself seems to have abandoned it after the appearance of Nicholson's work, for the specimens in the United States National Museum bear the label, "*Stromatopora cystosa.*" I have adopted the Rominger manuscript name for this species.

No perfect specimens are available from which the general form and size of the coenosteum can be described; that it was of considerable dimensions is shown by the fact that fragments are found at least two inches in vertical extent. The concentric elements are nearly flat, pointing to a considerable horizontal development. Owing to its similarity to *C. fastigiatum* there can be little doubt that the general outline was practically the same.

The skeleton consists of a continuous series of thin laminae, so spaced that five, with the four intervening spaces, occupy the distance of 1 mm. The general horizontal direction of these elements is maintained throughout the coenosteum, but they are bent upwards at irregular intervals into sharp ridges and unsymmetrical points, which may or may not reach the overlying lamina. The walls of these upward inflections sometimes coalesce, so as to present, in vertical section, the appearance of true pillars. The upward folds of the laminae appear on weathered surfaces as vermiculate ridges.

Vertical sections (Pl. VII, fig. 3) show the general horizontal character of the laminae, their upward inflections and the pseudo-pillars to which these inflections sometimes give rise.

The irregular character of the network is the result of the fact that we are not dealing with regularly spaced true pillars, but with the cut edges of upturned ridges which do not run in a parallel direction. It sometimes happens that the continuity of a lamina is preserved beneath the upward inflections by an adventitious sheet which restores its horizontal character.

Tangential sections (Pl. VIII, fig. 8) exhibit no astrorhizal systems and show practically no dots as the ends of true pillars. The whole section is made up of irregular vermiculate lines representing the cut edges of the laminae and their inflections.

Observations.—There can be no doubt that the coenosteum of this species is built up on precisely the same plan as that of *C. fastigiatum.* The only difference is that the laminae in the latter species are bent into folds as well as being minutely inflected. Between typical examples of the present species and of *C. fastigiatum* many intermediate forms are found, showing varying degrees of folding. One of these is shown in Plate I, fig. 4. The similarity to fig. 3 of the same plate is striking. It will be observed that the vesicles are a little larger and coarser than in the case of commoner examples of *C. fastigiatum* (fig. 8), but otherwise very little difference is presented. Had not *C. fastigiatum* been already established as a distinct species, I should be inclined to group it with the present examples as a variety of *C. cystosum.* A tangential section of this variety is figured on Plate VIII, fig. 6. The cut ends of the pillars are seen as dots which are joined into vermiculate lines, exactly as in *C. fastigiatum.* In fact, this section bears out the previous statement that *C. cystosum* passes by insensible changes into *C. fastigiatum.*

The case referred to by Rominger, where several layers of vesicles are banded together and bounded by a sharp line, is illustrated in Plate I, fig. 5. The vesicles are smaller and have been partially disrupted by the forces of mineralization, but the general structure is similar. Nevertheless, sufficient difference is shown to suggest a different species, and I should have inclined to that view, except for the fact that a somewhat similar phenomenon is shown in the case of certain specimens of *C. vesiculosum* (Plate VIII, fig. 2). That there is enough difference to justify a variety is seen by the following comparison. The single, straight lamina is well defined and is covered by a distinct layer of cells which pass into those of the ordinary type. Above, there is a layer of smaller cells with thinner "walls," which are broken at the top so as to leave an open space beneath the straight lamina of the next succeeding group. A tangential section is shown in Plate VIII, fig. 8. This section is cut obliquely, so as to pass through the different parts of a layer. The lower part traverses the finer upper part of a layer. The open band passing irregularly across the figure represents the interspace at the top of a layer, and the upper part shows, first, the coarser cells of the basal portion of the next layer, and, second, the finer cells of this stratum. I propose for this variety the name *Clathrodictyon cystosum* var. *lineatum*.

Locality—Drummond Island, Iowa, Drift of Ann Arbor. Probably also Kentucky. I have no certain examples from Canada, although many badly preserved specimens from Manitoulin Island show some evidence of the minute structure of this species.

CLATHRODICTYON FASTIGIATUM, *Nicholson*.—Plate VII, Fig. 8, and cf. Plate VII, Fig. 4, and Plate VIII, Fig. 6

For the synonomy and description of this species see page 18 of "Guelph Stromatoporoids."* Though common in the Guelph, it has not hitherto been recognized in the Niagara formation, but I have no doubt as to its occurrence. It is not uncommon in Manitoulin and Drummond islands. U.S.N.M. specimen no. 36924, from the drift of Ann Arbor, should also be placed under this species. It is also found intergrown with *Syringopora* in northern Michigan. (Plate I, fig. 8). A badly preserved specimen belonging to the Geological Survey of Canada, and procured from the Pagwachuan river west of Hudson Bay, apparently belongs here.

As already stated, *C. fastigiatum* is little more than a variety of *C. cystosum*. Typical examples are, however, finer than the folded variety of *C. cystosum*, but no essential difference exists. Compare Plate VII, figs. 2 and 8, and compare Plate

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*University of Toronto Studies, Geological series, no. 4.

VIII, fig. 6, with Nicholson's figure of *C. fastigiatum* (Pl. XIX, fig. 4, of his monograph).

Group of CLATHRODICTYON STRIATELLUM

CLATHRODICTYON STRIATELLUM, *d'Orbigny*
CLATHRODICTYON OSTIOLATUM, *Nicholson*
CLATHRODICTYON DRUMMONDENSE, *sp. nov.*
CLATHRODICTYON RECTUM, *sp. nov.*

CLATHRODICTYON STRIATELLUM, *d'Orb.*

For synonomy and description see "Guelph Stromatoporoids," page 14, and add *Coenostroma botryoideum*, Spencer, and cf. *Stromatopora concentrica*, Hall (Pal. N.Y., Vol. II, p. 136, Pl. XXXVII, 1851). I have little doubt as to the occurrence of this species in considerable abundance in the Niagara, but it must be admitted that no absolute proof is available. Dozens of specimens have been sectioned and examined, but nothing more than faint indications of the double-based pillars have been made out. On the other hand, the spacing of the pillars and laminae in the specimens referred to is exactly that required for this species. The conditions of preservation are such that the minute structure is largely destroyed, either by crystallization, as in the forms from Hamilton, Ont., or by silicification, as shown in the Manitoulin and Kentucky specimens. I would include here all the forms with straight laminae, properly spaced, and not exhibiting the "nipple-like prominences" characteristic of *C. ostiolatum*. I am still of the opinion that *C. striatellum* is more common in the Guelph than is *C. ostiolatum*.

In the Guelph examples, the double-based pillars are often to be seen in specimens which show no trace of the "nipple-like prominences." The Niagara examples are badly preserved, but hundreds of specimens were examined in which the skeletal structure conforms to that of *C. striatellum*. A great diversity in the shape of the coenosteum was observed; in fact, I am being forced to the conclusion that, in many species at least, the outward form is the result of circumstance, and of no determinative value whatever. Among the specimens referred to above were laminar expansions, hemispheric masses, globose and botryoidal types and—*C. ostiolatum*. It is only a natural dislike, on my part, to question the conclusion of such an eminent authority as Professor Nicholson that prevents me from reducing *C. ostiolatum* to the rank of a variety of *C. striatellum*. The "ostioles," too, are by no means confined to *C. ostiolatum*, for laminar expansions 10 cm. wide and only a few mm. thick show these structures to perfection, and no trace of "nipples." A new difficulty is presented by this fact. European examples of *C. striatellum* show no such structures. What are we to do? Admit that American specimens of *C. striatellum* may have "ostioles" and astrorhizal systems, or establish a new species—which could never be distinguished by microscopic examination? It seems best to restrict *C. ostiolatum* to the forms presenting the "nipples" and to include all the others under *C. striatellum*.

The form to which Spencer gave the name *Coenostoma botryoideum** is, in my opinion, merely a botryoidal type of *Clathrodictyon striatellum*, and is instructive in that it shows the transition to *C. ostiolatum*.

Locality.—Common in the upper beds at Hamilton, Ont. Less frequent at Owen Sound and in the islands of Lake Huron. Probably occurs in Kentucky and at Niagara Falls.

CLATHRODICTYON OSTIOLATUM, *Nicholson*

For synonomy and description see "Guelph Stromatoporoids," page 12. This form is common in the upper beds at Hamilton (Carpenter's and Gallagher's quarries) along with *C. striatellum* and *Stromatopora constellata*. It probably occurs at Owen Sound, and I have one very fine example from Fossil Hill, Assiginack township, Manitoulin Island. I do not recognize it in any of the specimens from the United States National Museum.

CLATHRODICTYON DRUMMONDENSE, *sp. nov.*—Plate VII, Fig. 5; Plate VIII, Figs. 3 and 7

Coenosteum sub-spherical, exfoliating readily and presenting smooth surfaces. The type and only specimen is 8 cm. in diameter.

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*Bull. Mus. Univ. State of Missouri, vol. i, no. 1.

The laminae are very irregularly arranged around the initial point of growth, about six of them with the fine interlaminar spaces occurring in the distance of 1 mm These horizontal elements maintain their straight course, although they are inflected to form "pillars," or rather ridges and irregular points. Downward as well as upward flexures occur, so that the interlaminar cells become polygonal in shape.

A vertical section of the type specimen is shown in Plate VIII, fig. 3. There will be noticed considerable variation in the spaces between the laminae, and still greater irregularity in the distance between the vertical elements. This appearance is the outcome of the fact that individual radial pillars exist only towards the top of an interspace, the major portion of the structures connecting the laminae being more of the nature of crescentic and irregular plates. In certain parts a high degree of regularity is shown, the cells of one interspace alternating with those of the layer below. This arrangement is still better shown in Plate VII. fig. 8. This plate was prepared from a section kindly lent by the United States National Museum. It evidently has been cut from an example of this species, and is said to have come from Louisville, Ky. Unfortunately, the specimen itself is not at hand.

Tangential sections (Plate VIII, fig 7) show the cut ends of the upward inflections as vermiculate and inosculating lines. Towards the top of an interspace, however, the radial pillars as such are more conspicuous. Owing to the spherical character of the coenosteum, a tangential section must cross several laminae. This gives the figure a concentrically banded appearance which was more conspicuous in the original photograph. As the darker matter representing the laminae was quite structureless, it was thought better to omit it in making the drawing.

Observations.—This species differs from *C. ostiolatum* and *C. striatellum* in the fact that the laminae are distinctly closer set, and that both pillars and laminae are much heavier. It also differs in the more crumpled character of the laminae and the alternate position of the pillars. From *C. cystosum* it differs in its finer structure and in the marked downward inflection of the laminae. Certain analogies are presented to *C. fastigiatum*, i.e., in the similar spacing and in the crumpling, but the present species differs in that the laminae are not folded as in *C. fastigiatum.* (Compare figures 7 and 8, in Plate X.)

Locality.—Drummond Island and Louisville, Ky. Probably rare in both places. The species is founded on a single specimen—U.S.N.M., no. 36814. Rainy island, Attawapiskat river, Canada, Geol. Sur. Canada.

CLATHRODICTYON RECTUM, *sp. nov.*—Plate IX, Fig. 9; Plate XIV, Figs. 1 and 2

Coenosteum hemispherical, reaching a diameter of 12 cm. and a height of 6 cm. Surface smooth or slightly undulating. Exfoliated laminae present a surface studded with papillae which represent the broken radial pillars. The composition of the coenosteum from a series of concentric layers is well shown in weathered specimens by reason of the facility with which the laminae exfoliate.

The specimens at hand are all highly silicified, so much so that any attempt to describe the detailed structure of the fibre is very hazardous. In a gross way, however, the general character of the reticulation is well marked. The laminae are very evenly spaced; five of them, with the four intervening spaces, occur uniformly in a vertical distance of 1 mm. The laminae are unusually thick, but whether this is the result of silicification or whether it is natural remains somewhat doubtful. In certain parts of a section a clear, delicate line may be observed in the middle of a lamina; in other cases a dark line is visible on both borders of a layer. It is this hazy indication of finer structure which renders it possible that the laminae may not really be as coarse as they appear. The pillars are also large, but they show the same evidence of original tenuity already described in respect to the laminae. Six pillars with the intervening spaces occupy a distance of 1 mm.

Vertical sections (Plate IX, fig. 9; Plate XIV, fig. 2) show the apparently coarse nature of the laminae and pillars, but a close inspection of the photograph shown in Plate XIV, fig. 2, will reveal the finer structure referred to. Tangential sections (Plate XIV, fig. 1) exhibit the cut ends of the pillars as small round dots in the interlaminar spaces. Where the section follows the course of a lamina, however, the pillars are much larger and show whorls of connecting processes.

Observations.—Owing to the imperfections of the specimens, this must be regarded as a very doubtful species. It is closely related to *C. striatellum*, d'Orb., as may be seen from the following points of similarity. The spacing of the pillars and laminae is exactly the same. The undulations of the laminae and the consequent occurrence of low elevations on the surface are features in common. The increase in size of the pillars where the laminae are crossed and the general appearance of the tangential section are alike. If the pillars and horizontal sheets are really as stout as they appear we have a decided difference, but I am inclined to believe that the finer structure referred to is really organic. Admitting this, there remains only one point of difference—the pillars do not arise by double bases from the upper lamina and they never fall short of the layer next below. Nevertheless, in view of the imperfect state of preservation, it must be admitted that the species is possibly identical with *C. striatellum*.

Locality.—Louisville, Ky. Several specimens collected by Mr. G. K. Greene of New Albany, Ind.

STYLODICTYON COLUMNARE, *Nich.*—Plate XII, Figs. 1 and 2

SYRINGOSTROMA COLUMNARE, *Nich.*, Pal. Ohio, p. 253, pl. xxiv, figs. 1, 1a, 1875

STYLODICTYON COLUMNARE, *Nich. and Murie*, Jour. Linn. Soc., vol. xiv, p. 221, 1878

STROMATOPORA WORTHENI, *Rominger*, Proc. Acad. Nat. Sci. Phil., p. 53, 1886

STYLODICTYON COLUMNARE, *Nich.*, Mon. Brit. Strom., p. 79, pl. vii, figs. 7-11, 1892

It would be superfluous here to go into the description of the genus *Stylodictyon*, or to discuss its validity. Nicholson has retained it in his monograph, although Rominger attacked his position with some success in the previously mentioned article in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1886. Suffice it to say that the characteristic feature of the coenosteum is the possession of large vertical pillars traversing the reticulation of what is otherwise an ordinary *Clathrodictyon*. These columns are formed by the upward flexure and partial coalescence of the laminae, together with an indeterminable amount of spongy connective tissue.

Stylodictyon columnare is an Upper Helderberg species; its occurrence in the Niagara must be regarded as doubtful. My authority for placing the species here is found in the fact that the United States National Museum possesses a specimen (no. 41210) which I am unable to refer to any other species. This specimen is labelled, "Stromatopora, Niagara, Louisville, Ky.," and was collected by E. O. Ulrich. While not familiar with the rocks at this locality, I am impressed by the general difference of this specimen from any others of a large collection, and it may be that a mistake in labelling has occurred.

The specimen is a weathered fragment, 12 cm. by 7 cm., and is apparently part of a large coenosteum. The skeleton consists of delicate laminae, of which from four to seven occur in the space of 1 mm. The laminae are connected by radial pillars about the same distance apart. Instead of remaining horizontal, as in a typical *Clathrodictyon*, the laminae are bent sharply upwards at distances varying from 1½ to 2 mm. or more apart. Through the centre of each upturned portion runs a pseudo-column, which is composed of the partially coalesced pillars and laminae and a certain amount of spongy tissue. On the surface these columns appear as blunt points standing well above the general level of the last formed lamina.

Vertical sections (Plate XI, fig. 1) exhibit the structure already described. There is, as stated by Nicholson, a slight evidence of grouping in the laminae, some being closer together and others farther apart, and although pillars are absent in places I am disposed to regard this fact as the result of mineralization rather than an organic peculiarity. The section figured is not quite vertical, so that the large pillars are not continuous.

Tangential sections show the radial pillars as minute dots. The large pillars appear as distinct centres around which the upturned edges of the laminae appear as rings (Plate XI, fig. 2).

Nicholson's statement that the tangential sections "do not show the cut ends of the pillars, but rather show a reticulated tissue, similar to that of the *Stromatoporidae*" is not borne out by our specimen, for the pillars are clearly seen. It seems strange that the appearance from this aspect is so different in Nicholson's figure, and I can explain it only on the assumption that he was dealing with a more mineralized specimen than the one in my hands. Of course, there is always the possibility that the species are not identical, but, from the general similarity of structure and the correspondence in the spacing of both laminae and large and small pillars, I incline to the view that we are dealing with an example of *S. columnaris*.

Locality—Louisville, Ky., U. S. N. M., no. 41210, E. O. Ulrich, coll.

Family—LABECHIIDAE, *Nicholson*

Genus—LABECHIA, *Edwards and Haime*

This genus is in a very unsatisfactory state of definition, but if we adopt Nicholson's conception of its characteristics it may be made to include all those forms in which large radial pillars pierce through a mass of vesicular tissue. In other words, the coenosteum consists of large vertical pillars connected by bars and plates which do not coalesce to form laminae. It will be observed that the external appearance of such forms is very like that of the coral genus *Syringopora*. Here we have a fertile cause of difficulty, as the distinction between *Labechia* and *Syringopora* must depend on the internal structure of the pillars or tubes, as the case may be. Nicholson states that the pillars of *Labechia* are for the most part hollow; this tends to increase the resemblance to *Syringopora*. While the hypothetical distinction is easy, the practical determination is almost impossible, as a slight degree of mineralization converts the tubes of *Syringopora* into solid pillars. I have examined a number of the finer *Syringopora* from Ontario, and have few examples that show the vertical elements to be incontestably tubes. It is, therefore, difficult for one to conclude that the pillars of *Labechia* are not infiltered tubes of *Syringopora*. Nevertheless it is well to retain the genus *Labechia*, but it must be used strictly in the sense defined by Nicholson, and must not include forms in which laminae are apparent. It has been a practice to label as *Labechia* all papillose examples showing pillars in vertical section; this is entirely erroneous, as the papillae are, in nearly all cases, upward inflected portions of continuous laminae, and not the free ends of radial pillars. It was to forms of this kind that Lindström and Roemer applied the name *Labechia*, and in my opinion

Nicholson's explanation of the discrepancy between his definition and theirs is entirely inadequate.* A new genus must be established for the reception of these laminated forms if we are to keep the genus *Labechia* in the sense defined by Nicholson.

I have observed no undoubted example of *Labechia* in the Niagara material at my disposal. Provisionally, however, there may be referred to this genus the form about to be described.

LABECHIA DELICATULA, *sp. nov.*—Plate IX, Figs. 4, 5 and 6

This is a very beautiful and exquisitely preserved organism, differing in many respects from any described member of the great group of Stromatoporoids. The coenosteum consists of a delicate incrusting growth on small branching Bryozoa, the total thickness being not more than ⅖ of a mm. The surface shows a series of minute papillae arranged, more or less regularly, in diagonal lines winding around the branches of the host.

Vertical sections (Pl. IX, figs. 4 and 6) show the coenosteum to consist of comparatively stout, hollow tapering pillars and numerous close-set horizontal laminae or connecting elements. The pillars seem to have a proper wall, although the laminae are upturned towards the pillars and coalesce with its walls. These vertical elements are somewhat irregularly spaced, but average ⅓ of a mm. apart; they terminate on the surface as minute papillae with solid apices, but this appearance may be due to mineralization. The connecting laminae are very delicate, flexuous plates, which do not appear to be independent, but coalesce, more or less, with one another. They are inflected upwards towards the pillars and unite with their walls. Whether the pillars are formed by the upturned laminae or whether they are independent structures it is impossible to say: in some cases, at least, they seem to have their own proper wall, with which the upturned and consequently crowded laminae are fused. About ten of these delicate horizontal sheets appear in the total vertical extent of the organism.

Tangential sections (Pl. IX, fig. 5) show the cut pillars as minute rings, surrounded by a dark band representing the severed edges of the laminae where they are upturned and crowded together at the borders of the pillars. Certain parts of the section show the severed edges of the laminae, and where it is very thin these cut edges appear as concentric rings around the pillars. The size of the ring representing the proper wall of the pillar varies with the depth of the section from the surface.

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*Mon. Brit. Strom., p. 83.

Observations.—There can be little doubt that this species is properly to be included with the Stromatoporoids: it possesses well marked vertical and horizontal elements, although these latter structures have not the continuity exhibited by most species of Stromatoporoids. The generic affinities are doubtful. The extreme tenuity of the skeletal matter and the comparatively large size of the vertical pillars should perhaps justify the establishment of a new genus. The form in question resembles *Labechia* in the independence of the pillars and in the somewhat vesicular character of the tissue built up by the laminae; it differs, however, in the wide spacing of the pillars and in the continuous surface. From the new genus about to be described (*Chalazodes*) it differs in that the horizontal elements are not continuous through the substance of the pillars. It seems advisable, therefore, to refer the species to the genus *Labechia*.

Locality.—Osgoode, Ind. U.S.N.M., no. 41218. Six small specimens from the collection of E. O. Ulrich. (Two of these were sacrificed in order to make the necessary sections.)

Genus—CHALAZODES,* *gen. nov.*—Plate XI, Figs. 1 to 8

The pronounced element in the coenosteum is the continuous horizontal lamina, sometimes very thin, sometimes of considerable thickness. The laminae are regularly inflected into upwardly directed, more or less conical points. Successive laminae are not in actual contact with each other, although the papillae of all laminae are superimposed on those of the layers below. The connection is established by vertical pillars of a less dense structure than the laminae, and these pillars are coincident with the position of the papillae. The gross structure, therefore, resembles that of *Actinostroma*, but strong differences exist:

**Chalazodes* (χάλαζα, hail, εἶδος, form), a name descriptive of the papillose surface, for which I am indebted to Professor W. S. Milner, of University College, Toronto.

first, the laminae do not arise by whorls of fibres from the pillars: second, the whole coenosteum is coarser; third, the laminae do not terminate at the borders of the pillars, but continue through them, curving upwards as the pillars are encountered; fourth, the pillars themselves are less dense and structurally less important than the laminae; in fact, they are so unimportant and so ill-defined that in thin sections their presence is rather to be inferred than observed. The pillars are in no sense continuous structures, but are made up of successive masses of tissue passing from lamina to lamina. The pillar-like appearance is merely the result of the strict superposition of the papillae. All the specimens of this genus examined are in a poor state of preservation, presenting various degrees of calcification and of silicification. Remarkable differences in the appearance of sections and surfaces result, and it is only by the most careful observation that these different aspects can be correlated. The persistence of the laminae is the strongest characteristic; this results in the production of typical horizontal surfaces, which in well silicified specimens are capable of immediate recognition.

There can be no doubt that both Lindström and Roemer were dealing with examples of this genus when framing their definition of *Labechia.* Professor Nicholson, when discussing this latter genus, quotes as follows from Lindström:—" The coenosteum of *Labechia* consists, in its earliest stages of growth, of a very thin circular disc, with concentric lines of growth beneath, and having a superior surface studded with blunt spines, which radiate from the centre and also coalesce and form continuous ridges..........During the course of growth the primitive disc of *Labechia* is increased in thickness by the addition of successive thin strata, which closely conform to the subjacent fundamental crust, being elevated where the spines are situated. As these successive layers leave a small space between them and are in themselves very thin, they give rise to a false appearance of tabulae " (Ann. and Mag. Nat. Hist., ser. 4, vol. xviii, p. 4, 1876). Nicholson also gives the following summary of Roemer's conclusions:—" Prof. Ferd. Roemer (Lethea Palaeozoica, p. 543, 1883) describes the skeleton of *Labechia* as consisting wholly of very thin horizontal lamellae, which are superimposed the one above the other in a continuous series, all being in practically direct contact with one another, and being bent into a system of close-set conical elevations, which in the last-formed layer give rise to the surface-tubercles. According to this view there are in *Labechia no* radial pillars, *no* interlaminar spaces, and, of necessity, none of the vesicular tissue which I have described as filling all the spaces between the radial pillars." A great discrepancy is apparent between Nicholson's description of *Labechia* and the account given by the authors quoted. Nicholson explains this discrepancy by the assumption that the interstitial structure of pillars and vesicles had been destroyed in the specimens examined by Lindström and Roemer; he fails, however, to account for the presence of the well marked laminae-structures, which he distinctly states are absent in *Labechia*, as he understands that genus. I have before me a good specimen of *Labechia conferta*, Lonsd. It conforms exactly to Nicholson's description. I have also numerous examples of three different species from the Niagara, which conform to the descriptions of Lindström and Roemer. I cannot admit Nicholson's conclusion as to the generic identity of the forms, and, therefore, as *Labechia* is now confined to Nicholson's conception of it, a new genus must be established for those forms with continuous laminae and ill defined pillars. In the upward flexures of the laminae into pillars there is a strong suggestion of the genus *Stylodictyon;* moreover, the weathered surfaces of the two genera are strikingly alike. We have only to imagine the contraction of the reticular skeletal matter of *Stylodictyon* into *single*, wider-spaced lamin [illegible] produce *Chalazodes*. That Roemer, Lindström and Dybo [illegible] e dealing with examples of this genus is undoubted, as [illegible] nferred from Nicholson's rather full discussion of the matter in his description of *Labechia (?) schmidtii* in the Annals and Magazine of Natural History for July, 1896. Here he states, "I have come to the conclusion that the present form is unquestionably specifically distinct from *L. conferta*, and that it is very doubtful indeed if it can be referred to the genus *Labechia* at all." It seems strange that Nicholson abandoned this view in his monograph, where, as already stated, he brings all these forms under *Labechia*.

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CHALAZODES GRANULATUM, *sp. nov.*—Plate IX, Fig. 6; Plate XI, Figs. 1, 2, 7 and 8

The coenosteum consists of a series of laminae and pillars reaching a thickness, in the type specimen, of about 15 mm. and expanding horizontally to a circular mass of 100 mm. diameter. The laminae are very thin, and distant from one another about ½ mm. At points varying from ¾ to 1 mm. apart the laminae are bent upwards into sharp elevations. The papillae of each layer occupy a position directly above those of the layer below. The pillars are coincident with the lines of superimposed papillae and are of a much less dense structure than the laminae. The type specimen is encrusting on an *Alveolites*, so that its under surface is not observable, but it seems to be possessed of an epitheca. The last layer forming the exterior shows a minutely papillose, continuous and slightly undulating surface. (Pl. IX, fig. 6.)

A great diversity of appearance is presented, both by actual surfaces and sections, according to the state of preservation. The type specimen is particularly fortunate in having three distinct varieties of preservation in the one example, so that there is no doubt as to the correlating of the very different aspects shown. The upper part is entirely silicified, and the alteration has taken place in the following peculiar manner: The silica has been deposited on the laminae in the form of minute spherical concretions, so that on vertical polished surfaces the laminae are outlined as a series of white dots. On such surfaces the pillars are seen as very ill-defined lines, while the interstitial portions are represented by less closely aggregated and entirely unarranged granules of the same character as those lining the laminae. The surface papillae are much less pointed than would be expected from an examination of a vertical section, but this is explained by the fact that the granules of silica are aggregated on the elevations in such a way as to destroy the pointed character of the papillae and to render them quite rounded in aspect. This aggregation is caused by the silicification of the pillars, which must have been of an open, porous structure.

A portion of the coenosteum lying below the entirely silicified upper section appears to consist of a series of tubes simulating a coral or bryozoan; no sign of laminae or pillars is observable, nothing but close-set, continuous tubes. In an isolated example one would certainly think one was dealing with a badly preserved specimen of a monticuliporoid *Bryozoa;* but the seeming tube walls are seen to coincide with the interstitial spaces around the pillars. The explanation is as follows: Calcification began in the pillars and enlarged them, the thin laminae were disrupted, and afterwards the interstitial spaces were filled with silica. Subsequent solution has removed the calcite, leaving the interstitial silica as a series of coalesced tubes. The relation of the two differently preserved portions bears out this explanation, and its correctness is further attested by the fact that exactly the same process, resulting in a similar appearance, is to be observed in portions of the coenosteum of *Syringostroma*, other parts of which show clearly the large pillars typical of the genus. (Plate XI, fig. 2, is drawn to show the ordinary surface appearance in the right-hand portion. The left-hand half of the figure represents the coral-like aspect of the interstitial silica.)

The lower portion of the type specimen is entirely calcified, no trace of laminae or pillars is observable. The only fact to be learned by an examination of this portion is the position of the pillars. The calcification began in these elements, and enlarged them until they filled the interspaces and were closely crowded against each other. Vertical sections, especially when etched with acid, show vertical lines representing the points of apposition of the enlarged pillars. On cross sections these lines of union appear as a polygonal network.

Microscopically, vertical sections of the upper silicified portion show the laminae as a series of white dots (black, in transmitted light and in photo-micrographs). The upward inflections are distinctly seen, but the pillars are not observable, although they may be faintly made out on polished surfaces. (Pl. XI, fig. 7.)

Tangential sections present likewise a minutely granulated appearance; the laminae are scarcely apparent, but the cross section of the pillars is demarcated by a much closer aggregation of the spherules of silica. (Pl. XI, fig. 8.)

Microscopic sections of the middle, partially silicified, portion of the coenosteum reveal nothing further. Both vertical and tangential sections of the entirely calcified under portion fail to reveal either pillars or laminae as such. The lines of contact of the enlarged pillars are distinctly seen, but the highest magnification that can be employed shows that these lines are in no sense structural.

Observations.—The rough process of crystalline calcification which has evidently operated in the lower portion of the specimen disrupted and absorbed both the porous pillars and the laminae, so that nothing is apparent but the lines of contact referred to. In the middle of the coenosteum this process was arrested at a certain time, and silica filled in the remaining portion of the interstitial space. The upper portion, while structurally intact, was covered by granular silica, which gradually filled in all the interspace. This process has sharply outlined the laminae, but the pillars are apparent only by reason of the closer aggregation of the granules; from this fact I have concluded that the pillars were of very open structure, presenting much surface for the lodging of the granular silica. The presence of the laminae is undoubted; the occurrence of pillars is inferred from the lines of contact in the calcified portion, the tube-like interstitial silica in the semi-silicified part, the aggregation of granules seen in cross sections of the silicified portion, the faint outline of pillars on vertical polished surfaces, and the resemblance of the semi-silicified part to portions of the coenosteum of undoubted examples of *Syringostroma*. The diameter of the pillars is not determinable; in the illustrations, while the position of the pillars is correct, their size is conjectural only.

Locality—Drummond Island, Lake Huron. The type specimen is no. 36940 of the United States National Museum; it was collected by Dr. Carl Rominger and has borne the label, "*Labechia sp.*" U.S.N.M. no. 36936 consists of two specimens; one of them is a different species, but the other identical with that described above. Although both these specimens are supposed to have come from Louisville, Ky., the example of *C. granulatum* is evidently a fragment from the type specimen.

CHALAZODES MAGNUM, *sp. nov.*—Plate IX, Fig. 7; Plate X, Fig. 8; Plate XI, Figs. 5 and 6

Coenosteum growing from a concentrically wrinkled epitheca, and reaching a diameter of 300 mm., with a thickness of 60 mm. The pronounced elements, as in all examples of this genus, are the laminae, which form continuous sheets of considerable thickness. At intervals of about 2 mm. the laminae are bent sharply upwards into papillae. In the superposition of the layers, which are about 1½ mm. apart, the papillae of one layer occupy a corresponding position to those of the contiguous laminae. The various laminae are held together by pillars which rise from above the papillae and pass into the hollow on the under side of the layer next above. These pillars do not seem to be merely upward prolongations of the papillae, as the upper surface of the laminae may be clearly traced across the pillars. On fractured surfaces, the laminae, observed from beneath, show a series of depressions corresponding to the papillae. These depressions are in many cases smooth and empty, showing the continuous character of the laminae; in other cases they are partially filled by the broken upper ends of the pillars. The much poorer preservation of these pillars shows them to have been of a looser texture than the laminae. Whether these structures tapered upwards into the hollows of the overlying lamina or whether they maintained a uniform diameter it is impossible to say. It would seem, by analogy with the other species of the genus, that they were pretty nearly cylindrical. The upper surface presents a uniform papillose aspect, with the elevations averaging 2 mm. apart. (Pl. IX, fig. 7; Pl. XI, fig. 6.)

Vertical sections show the laminae to be about ⅖ mm. in thickness and to be considerably thinned where they are bent upwards; they are outlined by a dark upper and lower margin, which appearance may possibly be due to the fact that the laminae are double; it is more likely, however, to be the result of silicification, which has, in all cases, destroyed the finer structure of the skeletal matter. Plate IX, fig. 5, shows the laminae exactly as they appear; the pillars are restored. In the direct photographic reproduction (Pl. X, fig. 8) the pillars are not perceptible. Tangential sections are quite unsatisfactory and reveal nothing further.

Observations.—The structure of this species is almost identical with that of *Chalazodes granulatum,* but it is much larger and coarser in texture. The slopes of the papillae are more concave, and the mode of preservation is different. Although the pillars cannot be clearly made out, their presence is indicated by breaks in the interstitial matter along the line of the superimposed papillae as viewed in vertical section. On certain broken surfaces they can also be recognized as clear, crystalline, silicified rods. While the structure is more or less obscure, the form is capable of easy identification by means of the characteristic surface.

Locality.—Tehkummah and Assiginack, Manitoulin Island, Point Detour. U.S.N.M., no. 36941.

CHALAZODES SPINDICANDUM, *sp. nov.*—Plate IX, Fig. 8; Plate XI, Figs. 8 and 4

LABECHIA SPINDICANDA, *Rom.*, MSS

Coenosteum known by fragment only, but it appears to have had the form of a circular expansion of 200 mm. diameter, with a central thickness of 20 mm. The laminae present the same characteristics as the other members of the genus, being upwardly inflected into points which are situated from 1 to 1½ mm. apart. The distance from lamina to lamina is somewhat variable, but averages about ½ mm. The surface is papillose, the elevations being more pointed than in *C. granulatum*. The spacing of the pillars and laminae is intermediate between *C. granulatum* and *C. magnum*, otherwise the general structure is the same. The type and only specimen is partially silicified, and weathered in such a manner as to disclose the structure in an excellent manner. Polished surfaces, however, are destitute of structural features; partly on this account, and partly through a disinclination to cut up a small and unique specimen, no sections were prepared.

The vertical aspect of the weathered specimen shows the continuous laminae, curving upward and passing into the pillars. By reason of varying degrees of silicification the laminae have disappeared in places, in others they are close together, and in some parts they are unduly thickened. The pillars are clearly shown, and seem to have been of firmer structure than in the other two species. (Pl. XI, fig. 3.)

A surface view shows the continuous laminae with the sharp conical points. In places the tip of the point is perforated, as if the pillar had broken down and carried the centre of the elevation with it. In other places the upper lamina is removed and the pillars stand up as elongated points from the layer next below. This feature suggests *Labechia*, but the presence of the continuous laminae must remove the species from that genus. These various appearances are shown in Plate XI, fig. 4.

Observations.—The features which distinguish this species from the other members of the genus are the spacing of the pillars and laminae, and the more persistent character of the latter elements. It must be remembered, however, that the polished surfaces show no more evidence of pillars than do the other species, and it is perhaps only owing to the peculiar conditions of preservation and weathering that they are so apparent here.

Locality.—The type specimen is no. 36936 of the United States National Museum, and was obtained by Dr. Carl Rominger from Louisville, Ky., The label accompanying the specimen carries the name *Labechia* only, but on the specimen itself is written, "*Labechia spindicanda.*" I have adopted this specific name and suppose it to have originated with Dr. Rominger.

CHALAZODES ROMINGERI, *sp. nov.*—Plate XIV, Fig. 2

The specimen on which this species is founded is so badly preserved that no justification for its description can be given, beyond a desire to include in this paper all the Stromatopora-like organisms with which I am acquainted. The coenosteum consists of a series of thin, superimposed, undulating plates, bearing on their surface large spines which were probably hollow. A remarkable feature is that these spines are strongly oblique to the general surface of the plate. They may or may not reach across the interlaminar space; when they do a firm fusion with the upper plate is effected. There is a rough evidence, at least in parts of the specimen, that the spines are continuous, i.e., that they pass from plate to plate so as to form continuous columns traversing the whole coenosteum. Cross sections, however, show these elements as circular holes of variable size, indicating that they taper to a point in many cases. Whether they are formed by upward flexions of the plate is not clearly revealed. It is questionable whether they are hollow or solid, as some of them are filled with clear crystalline calcite and others show the limestone matrix in the interior. No trace of minute structure is visible. The plates are from 3 to 4 mm. apart, and the spines are placed at somewhat greater intervals. I would conclude, from a general examination of the specimen, that the spines are formed by upward inflections of the plates; that directly, or by the assistance of supplementary tissue, they united the laminae; and that they are, or were, "continuous." All these conclusions are open to question, but they enable us to find a place for this very remarkable organism under the genus *Chalazodes*. I have no doubt that this is one of the specimens referred to by Rominger in his previously quoted work in the Proceedings of the Academy of Natural Sciences of Philadelphia, where he says, "A very similar concentrically laminated fossil, but on the whole of coarser structure..........is not rare in the drift deposits of Ann Arbor."

Locality.—Drift of Ann Arbor, Mich., U.S.N.M., no. 36813, C. Rominger, col.

ROSENELLA (?) MANITOULINENSIS, *sp. nov.*—Plate XII, Fig. 3; Plate XIV, Fig. 8

Coenosteum composed of a series of superimposed thick plates, of which nine occur in the space of 5 mm. measured vertically. The whole organism grew from a coarsely wrinkled basal epitheca and reached large dimensions. It appears to have been circular and spreading in character, and probably reached a diameter as great as 30 cm. Its greatest thickness does not seem to have exceeded 3 cm. The plates are continuous throughout the coenosteum, and are from ¼ to ½ mm. thick. Their thickness is, however, greatly reduced by the ramifications of large and strong astrorhizal canals over their surface. These canals apparently break up and communicate with each other, so that the surface presents the appearance of stout tubercles and ridges with deep canals and passages between them. The astrorhizal centres are about 5 mm. apart. In all specimens examined, and the species is by no means uncommon, absolutely no structure can be made out in the skeletal fibre.

Vertical sections (Pl. XII, fig. 3) show the cut edges of the laminae, and the cross sections of the ridges as blunt, ascending points. Very seldom do these points reach the layer next above. In some parts of a section a faint line can be made out, passing over the summit of the points, and sagging into the hollow between without reaching the basal plate of the lamina. Tangential sections are useless; a much better conception of the tangential aspect may be obtained from a view of the surface as shown in Plate XIV, fig. 8.

Observations.—We have to deal here with a type of Stromatoporoid which can be briefly defined as follows:—Coenosteum a series of superimposed sheets, the upper surfaces of which are deeply impressed with ramifying astrorhizal canals. The layers are independent, or nearly so, and appear to represent successive incrustations. There is no described genus with which this form can be with certainty associated. The closest relationship is with the genus *Rosenella*, which it resembles in its continuous sheets and tuberculated surface. It differs, however, in the fact that the interspaces between the sheets are not lenticular but continuous throughout the coenosteum, and in the presence of astrorhizae. It is not difficult, however, to explain these differences. In the first place, with regard to the continuity of the layers, we have only to imagine the vesicles as greatly extended to produce the present form. The species described by myself as *Rosenella glenelgensis* shows an intermediate condition in this respect; for in that species the vesicles are much more extended laterally than in any of the forms ascribed by Nicholson to the genus *Rosenella*. With regard to the astrorhizae, it is quite possible that they were overlooked by Nicholson; he does not mention having examined a surface and without a surface their presence would not have been [illegible]. The horizontal canals, by forming depressions in the plate, give the appearance of points to the substance between them when viewed in vertical section. If, therefore, I may be permitted to amend the genus *Rosenella*, so that it may possess astrorhizae and continuous interlaminar spaces, the present species finds a natural place in that genus. I would point out that *Rosenella glenelgensis* also possesses astrorhizae and, as has been already shown, approaches nearer to the type of the genus in that the interlaminar spaces are vesicular but extended.

Locality.—Manitoulin Island, not uncommon. Specimen no.

36827 of the United States National Museum apparently belongs here, but the preservation is much poorer. These specimens are from the Rominger collection (drift of Ann Arbor), and are labelled *Stromatopora rudis*, sp. nov. I have not adopted Rominger's manuscript name because I am not sure of the identity of the material, and because I have made the specimens from Manitoulin Island the type.

Section B. (" Milleporoid " Group.)

Family –STROMATOPORIDAE, *Nich.*

Genus—STROMATOPORA, *Goldfuss*

STROMATOPORA CONSTELLATA. Plate XIII, Figs. 7, 8 and 10.

STROMATOPORA CONSTELLATA, *Hall*, Pal. New York, vol. ii, p. 324, pl. lxxii, figs. 2a, b, 1851

STROMATOPORA CONCENTRICA, *Hall*, Pal. New York, vol. ii, pl. lxxiii, figs. 2, 2a, 2b, 1851

COENOSTOMA CONSTELLATUM, *Spencer*, Bul. Univ. State of Missouri, vol. i, no. 1, p. 48, pl. vi, fig. 11, 1882

STROMATOPORA CONSTELLATA, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 137, 1896

STROMATOPORA CONCENTRICA, *auc*

STROMATOPORA CONSTELLATA, *auc*

COENOSTROMA CONSTELLATA, *auc*

cf. STROMATOPORA HUDSONICA, *Dawson*, Quart. Jour. Geol. Soc., vol. xxxv, p. 52, pl. iv, figs. 9a and 9b, and pl. v, fig. 10, 1879

cf. STROMATOPORA HUDSONICA, *Nicholson*, Mon. Brit. Strom., p. 172, 1891.

cf. STROMATOPORA HUDSONICA, *Nicholson*, Ann. and Mag. Nat. Hist., p. 312, pl. viii, figs. 1-3, 1891

Hall's original description of *Stromatopora constellata* is as follows:—" Massive, hemispheric, spheroidal or irregular; composed of thin concentric layers, which are penetrated by minute vertical tubes or cells; surface of layers nodose, each elevation being marked by irregular stellate impressions with undulating and bifurcating rays; intermediate spaces smooth, or having only the minute cell apertures. This species presents no important characters to distinguish it from *S. concentrica*, except the uneven surface of the laminae, and the stellate impressions on these elevations. The size of the minute cell is apparently the same as in *S. concentrica;* and in such specimens as break only vertically there is no positive means of distinguishing this species beyond the undulations of the laminae which correspond to the uneven surface. It seems, indeed, probable that it may be only a variety of *S. concentrica*, presenting this peculiarity in its mode of growth. *Locality and Position.*—In the coralline limestone at Schoharie.

As true examples of *S. concentrica* do not occur in the Niagara, it seems likely that Hall was dealing with two varieties of the same species—one in which monticules are present and one in which they are not. Numerous examples of both varieties are at hand, but I have been unable to make out any difference in the skeletal matter. An amended description of *S. constellata* follows:—

Coenosteum massive, hemispheric, spheroidal or irregular. The commonest type is hemispheric, and in this form the species reaches a large size, possibly a foot or more in diameter. Latilaminar structure distinct, but the latilaminae vary greatly in thickness. Exfoliation easy, presenting smooth or gently undulating surfaces. Small, low, rounded mamelons may be present or absent; when present they are situated about 5 mm. apart. Small astrorhizal systems appear on nearly all surfaces, even where no other structure is observable; they are very small—not more than 2 mm. in diameter—and with very few branches. The spacing of these systems is extremely variable—from 3 to 6 or 7 mm. As I have already stated, the distribution of astrorhizae is of little or no diagnostic value. In the variety with mamelons, the astrorhizae generally coincide in position with these eminences, but even this is not rigidly true. The skeletal matter consists of radial pillars and concentric laminae, which are intimately fused, but not sufficiently so to obliterate their individuality. On an average seven pillars appear in a distance of 1 mm. They are separated by narrow interspaces representing the zooidal pores. The laminae are less distinct than the pillars, but, like them, occur to the number of seven in the space of 1 mm. The skeletal matter is rather coarsely porous.

Vertical sections (Pl. XIII, figs. 7 and 8) show the vertical and horizontal elements forming a network with relatively thick meshes. The cut ends of the astrorhizal canals are apparent as interspaces of a more or less rounded character, and the zooidal pores as minute tabulate tubes between the pillars. When the section is thick the laminae are most pronounced and continuous, because the zooidal tubes are of such small calibre that the section exceeds them in thickness: the thinner the section the more zooidal tubes are seen to hold their course through the laminae. This is an obvious fact, but one must remember it, or there is grave danger of misinterpretation. Fig. 8 is a slightly intensified photograph, and fig. 7 a purely diagrammatic drawing.

Tangential sections (Pl. XIII, fig. 10) show the astrorhizal canals as prominent features, and the minute round orifices representing the cross section of the zooidal pores.

Observations.—Professor Nicholson has opened the question of the identity of *S. constellata,* Hall, with *S. typica,* Rosen. The conclusion of that eminent authority is as follows:—"I am strongly disposed to think that it is really identical with *S. typica*..........If this identity should be proved, then Hall's name should, strictly speaking, have precedence over that of Rosen. The real nature of Hall's *Stromatopora constellata* could, however, be established only by an investigation of the original specimen, if even then; since the brief description with its accompanying figures is not sufficient to establish clearly so much as the generic position of the fossil. Under these circumstances it would appear unreasonable to abandon the name of *S. typica* for that of *S. constellata*, even were the identity of the two to be ultimately proved; since Rosen based his species on well preserved specimens, and illustrated its characters by admirable and thoroughly recognizable figures."

Professor Nicholson's specimen was procured from Hamilton, Ont., and was supplied by Dr. Spencer, who considered it identical with Hall's *S. constellata.* I have at hand numerous examples from Hamilton, which I have compared with slides kindly lent me by Professor Clark, of Albany. These slides, I am assured, represent the species in its typical locality; they are identical with those prepared from the Hamilton material. There can be little doubt, therefore, that Nicholson examined true specimens of *S. constellata.*

It is a waste of time to go further into the question. After examining a specimen of *S. typica*, identified by Nicholson himself, and comparing it with numerous specimens of *S. constellata*, I am unable to say that they are identical, and likewise I should hesitate to state that they are not. The two are remarkably alike, and the difference of no higher rank than that of variety. The most striking difference, and one not referred to by Nicholson, is the greater perfection of the laminae in *S. constellata.* I believe the forms to be identical; Hall's name is the older, it has been largely used in American literature, there can be no reasonable doubt as to the identity of the type, and I propose, therefore, to retain *S. constellata* for our North American variety. For convenience of comparison I have introduced tangential sections of both species, photographed on the same scale of magnification and reproduced almost without retouching. (Plate XIII, figs. 9 and 10.)

Through the kindness of Dr. Whiteaves I have had the opportunity of examining specimens of *Stromatopora* from the Equan and Little Current rivers, west of Hudson Bay. These specimens are very poorly preserved, but doubtless they are examples of ***Stromatopora hudsonica***, Dawson. In the Annals and Magazine of Natural History for April, 1891, Nicholson discusses at length the relationship between *S. typica* and *S. hudsonica.* He decides that they are distinct, for the following reasons:—

"*a.* The astrorhizae are regularly arranged in vertical systems, each system having an axial wall-less canal of comparatively considerable size.

"*b.* As a result of the above, the surface shows numerous minute, pointed mamelons, each of which is perforated at its summit by the aperture of the axial canal of one of the astrorhizal systems.

"*c.* The centres of the astrorhizae are considerably closer together than in *S. typica*, in which species they are usually 5 or 6 mm. apart.

"*d.* The zooidal tubes are furnished with fewer tabulae than those of *S. typica*, and also communicate more freely, giving to vertical sections a more lax and open aspect. The apparent scanty development of tabulae may, however, be the result of poor preservation.

"*e.* The skeletal fibre is a little coarser and the skeletal network not quite so fine as in *S. typica.*"

It is to be regretted that Nicholson had not a specimen of

S. constellata at hand when he wrote the above comparison. The first three reasons establish the identity of *S. hudsonica* and *S. constellata.* The fourth is, in itself, doubtful; so that the slightly different grain is the only real difference between *S. constellata* and *S. hudsonica.* If we accept as proved the practical identity of *S. typica* with *S. constellata*, then all three species are alike. Still, for the reasons given, let us keep *S. constellata* for the American type, but let it include *S. hudsonica.*

A vertical section of *S. hudsonica* is introduced for comparison in Plate XIV, fig. 9. As the specimen from which this plate was prepared is in a very poor state of preservation, I have also reproduced Nicholson's figures of this species. (Plate XII, figs. 7 and 8.)

Locality.—Very abundant throughout the Niagara. Occurs in great masses with *Clathrodictyon striatellum* and *Clathrodictyon ostiolatum* in the upper beds at Hamilton, Ont. Both the smooth and monticulose varieties occur, as well as intermediate forms. Also at Lake Temiskaming, Manitoulin Island, Albany river, Cape Churchill, Equan river, Drummond Island, New York, etc. It probably also occurs at Louisville, Ky., and elsewhere, but the state of preservation of specimens from this locality is not good enough to reveal the minute structure of the genus *Stromatopora.*

STROMATOPORA ANTIQUA, *Nich. and Muric.*—Plate XIII, Figs. 1-6

PACHYSTROMA ANTIQUA, *Nich. and Murie*, Jour. Linn. Soc. Zool., vol. xiv, p. 223, pl. iv, figs. 2-5, 1878.
STROMATOPORA ANTIQUA, *Nicholson*, Mon. Brit. Strom., p. 91, pl. v, figs. 8-11, 1886.
STROMATOPORA ANTIQUA, *Nicholson*, Ann. and Mag. Nat. Hist., ser. 6, vol. vii, p. 310, pl. viii, figs. 9-11, 1891.
STROMATOPORA ANTIQUA, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 136, 1897.

Nicholson's description of this species in full is as follows:—
"Coenosteum of considerable size, spheroidal or hemispherical in form, with a limited basal attachment, and apparently without an epitheca. The mode of growth is distinctively latilaminar, the entire coenosteum being made up of successively superimposed and perfectly definite strata, of which five or six occupy the space of 1 cm. measured vertically. The latilaminae are

often more or less extensively separated by minute intervals, and each consists of a single layer of zooidal tubes.

"The surface is undulating and is destitute of astrorhizal eminences or 'mamelons'; but there are well developed and much-branched astrorhizae, the centres of which are placed 4-5 mm. apart. The astrorhizae are not vertically superimposed in groups.

"The skeleton-fibre is minutely porous and is incompletely reticulated, the radial pillars to a large extent preserving their distinctness. Hence in tangential sections (Pl. XIII, fig. 1) the cut ends of the radial pillars are more or less clearly recognizable as rounded or oval porous masses, united by irregular and exceedingly delicate connecting processes. In vertical sections (Pl. XIII, fig. 3) the radial pillars are seen to be continuous from the top to the bottom of each latilamina—except when cut obliquely—and the spaces separating them are crossed by irregular transverse plates or 'tabulae,' and represent the zooidal tubes. About five or six pillars with their intervening tubes occupy the space of 2 mm. measured transversely. In tangential sections the zooidal tubes appear as small rounded apertures in the skeletal network, and the branching astrorhizae are well displayed.

"*Observations.*—*Stromatopora antiqua* presents us with a type in many respects intermediate between *Stromatopora*, Goldf. (as now defined), and *Syringostroma*, Nich. Though agreeing in general characters with the typical species of *Stromatopora*, the present form shows a strong relationship with *Syringostroma*, this being especially shown by the comparative distinctness of the radial pillars as definite structures. In the former genus, on the other hand, the vertical radial pillars are more or less undistinguishably merged with the horizontal connecting processes, the skeleton thus becoming completely reticulate. None of my specimens of *S. antiqua* are in a state of thoroughly satisfactory preservation, and it is possible that the examination of more perfect specimens might show that the species is properly referable to *Syringostroma*, from the known species of which it could be readily differentiated. In the genus *Stromatopora* the present form presents most likeness to *S. typica*, Ros., from which it is separated by the more complete preservation of the radial pillars, the less perfect reticulation of the skeletal framework as seen in tangential sections, and the more markedly latilaminar mode of growth.

"*Formation and locality.*—Niagara Limestone, Thorold, Ontario (coll. H. A. Nicholson). A poorly preserved specimen in dolomitic limestone of Niagara age from Durham, Ontario (coll. Geol. Survey of Canada), may also possibly belong to this species."

Several attempts have been made to prepare slides capable of throwing more light on the minute structure of this species, but no results have been obtained at all comparable with those of Nicholson. Most specimens fail to reveal any detail; it is only the best material which gives photographs as good as those shown on Plate XIII, figs. 5 and 6. As the average collector is very unlikely to get better specimens than those from which these figures are photographed, it is thought better to introduce them to supplement Nicholson's drawings.

Locality.—The only specimens in my collections which undoubtedly belong to this species are from Thorold, Ont., and Lockport, N.Y. Nevertheless I believe the species to have a wide distribution, but as the finer structure is almost invariably destroyed it is impossible to make definite statements in this respect. Specimens from the Nagagami and Drowning rivers, west of Hudson Bay, show a close relationship to *S. antiqua*, but the preservation is much too poor to render an identification at all certain.

STROMATOPORA INDIANENSIS, *sp. nov.*—Plate XII, Figs. 6 and 9

The coenosteum is known from fragments only, but it probably reached considerable dimensions—3 or 4 cm. in thickness, at least. The surface is undulating, with low, rounded mamelons, which are situated from 7 to 10 mm. from one another. At the summit of each mamelon an astrorhizal system opens; these systems are highly developed, with numerous large bifurcating horizontal canals.

Both laminae and pillars are very distinct for a member of the genus *Stromatopora*. The former elements have a thickness of from ¼ to ½ mm., and are separated from one another by a much smaller space. The laminae are bent into folds corresponding with the mamelons. The pillars are stout, continuous structures, of which three occur in the space of 1 mm. The space between them is small, and is normally occupied by minute vertical zooidal tubes. The horizontal elements of the astrorhizae, however, cause the pillars to be separated by a greater interval where they occur.

Vertical sections (Pl. XII, fig. 9) show the continuous character of the skeletal matter, the pillars and laminae being completely fused, although they may be seen to maintain their own general direction. Between the pillars and laminae the cut ends of the astrorhizal canals appear as round or irregular openings, while an occasional vertical zooidal tube is seen to occur between the pillars and to maintain its course through the laminae. Tabulae have not been observed in these tubes; their absence is more likely to be attributed to the state of preservation of the specimen than to an actual non-occurrence. The great thickness of laminae and pillars, and their pronounced continuity, give to vertical sections the appearance of a square network, as in the genus *Actinostroma*. Tangential sections (Pl. XII, fig. 6) show well the coarsely fibrous character of the tissue, the large astrorhizal canals and the cross sections of the zooidal pores. These latter structures have a diameter of about $^1/_{20}$ mm. and are situated ½ mm. apart. Owing to curvature of the laminae a large section cannot be prepared which is continuously horizontal; consequently a diversified aspect is presented by different parts of such a section. In the figure, an astrorhizal centre is situated at one corner. The plane of section is here coincident with a lamina, so that only zooidal pores and astrorhizal canals are perceptible. At a little distance from the astrorhizal centre the cross sections of a few pillars can be faintly made out. At a greater distance from the astrorhizal centre both pillars and laminae are cut obliquely, so that the general appearance approaches that of a vertical section.

Observations.—In the complete fusion of its elements this form approaches *Stromatopora*, but is by no means typical, as both pillars and laminae can be distinctly seen as such. The great thickness of the laminae and their fibrous structure, as well as the presence of zooidal tubes, also point to this association. On the other hand, the distinctness of the laminae and pillars suggests *Syringostroma*, and the general character of the skeleton is strikingly like that of *S. nodulata*, Nich. At the best, the genus *Syringostroma* is very ill-defined, and must be considered as including forms intermediate between *Actinostroma* and *Stromatopora*. The practical absence of pillars on tangential sections which are strictly horizontal inclines me to place the species under *Stromatopora*. From other species of *Stromatopora* this form is readily distinguished by the great size of the radial pillars.

Locality.—North Madison, Ind. The only specimen is no. 41216 of the United States National Museum, E. O. Ulrich, coll. A small fragment from the Little Current river, Canada, shows a structure comparable with that of *S. indianensis*, but it is too small and too badly preserved to render the determination of much value.

STROMATOPORA CARTERI, *Nich.*

This species should, perhaps, be included with the Niagara forms, as Nicholson has recognized it in "a loose boulder of Silurian age from Hayes river, Hudson Bay." I have also seen an example from the Pagwachuan river, where it is associated with a new species, of which a description, under the name of *S. wilsoni*, will appear in the April number of the Ottawa Naturalist. It is thought better to defer the detailed account of these forms until the remaining Upper Silurian formations are reviewed in this series.

Genus—SYRINGOSTROMA, *Nich. and Muric*

SYRINGOSTROMA NIAGARENSE, *sp. nov.*—Plate X, Figs. 1, 2, 5 and 7

STROMATOCERIUM NIAGARENSE, *Rom.*, MSS.

Coenosteum circular, explanate, about 8 cm. in diameter. Thickness in the centre, 15 mm. Latilaminar structure distinct, each layer having a thickness of from 2 to 4 mm. Surface smooth, undulating.

An examination of the minute structure reveals a series of large vertical pillars, which are continuous through successive latilaminae, but not through the entire coenosteum. These pillars are from ¼ to ⅕ mm. in diameter, and average a slightly greater distance apart. The horizontal elements are very thin but clearly defined calcareous sheets. At the lower level of a latilamina they may be as close as ¹⁄₁₀ mm. to each other, but higher up they may be as much as ¼ mm. apart. Astrorhizal systems well developed, with centres about 5 mm. apart.

Vertical sections (Pl. X, figs. 1 and 5) are hard to obtain in a direction perfectly parallel to the pillars; in fact, the pillars seem to be slightly irregular in their course, and to point out at certain intervals. Whether the appearance of the section is due to the former or latter of these causes it is impossible to say; probably both contribute towards this aspect, which is very typical of the species and enables one readily to differentiate it from the species next to be described. The pillars are also seen to coalesce at certain points, giving the appearance of forking. The laminae are sharply defined and are crowded close together at certain levels. It is this phenomenon which gives rise to the latilaminar appearance.

Tangential sections (Plate X, figs. 2 and 7) show the cut ends of the pillars as circular dots, quite variable in size. The tissue of the pillars is spongy. They coalesce to form the laminae by means of extremely irregular processes. The ramifications of the astrorhizal canals are conspicuous. The systems are not centred by a wall-less canal, and they are not superimposed.

Observations.—This species is very similar to the one to be described as *S. parallelum;* it differs in the slightly flexuous and non-continuous character of the pillars, in the wider interspaces between these structures, and in their more variable diameter as viewed in cross section. The laminae are sharper marked and much better developed than in *S. parallelum.* A curious feature, and one already referred to in the description of *Chalazodes granulatum*, is that certain cross sections present tne appearance of corals or bryozoans, similarly cut, in that the impression of a series of contiguous tubes is given to the observer. The explanation is that silica has filled the spaces around the pillars, and these structures have subsequently been removed.

Locality.—North shore of Lake Michigan (U.S.N.M., no.

36933); Drummond Island (U.S.N.M., no. 36821); Drift of Ann Arbor (U.S.N.M., no. 36935).

SYRINGOSTROMA PARALLELUM, *sp. nov.*—Plate X, Figs. 3, 4 and 6

The coenosteum of this species forms a circular expansion probably of 18 or 20 cm. diameter. Its thickness in the middle is as much as 3 or 4 cm. Surface smooth, undulating. The coenosteum is composed of a close-set series of large pillars presenting a remarkable degree of parallelism. The diameter of a pillar is about 1/5 of a mm., and the interspaces between them not more than a quarter as much. At distances of about 1¼ mm. the system of pillars is crossed by a well defined lamina. The intervening space shows evidence of about six more laminae, but they are broken down in the interspaces between the pillars and appear as serrated edges to these elements and as faint lines crossing them. These millimetre spaces may be considered as latilaminae. Well marked astrorhizal systems are present; they do not seem to be superimposed or to have a central canal. The pillars are arranged so as to give way to the horizontal canals. The astrorhizal systems are about 7 mm. apart.

Vertical sections (Pl. X, fig. 3) show the large, close-set and remarkably parallel pillars; their structure is somewhat porous or spongy. The well-defined laminae at intervals of about 1 mm. are a striking peculiarity, while the intermediate laminae are extremely ill defined.

Tangential sections (Pl. X, figs. 4 and 6) show the pillars to be arranged in a radial manner round the astrorhizal centres, the horizontal canals from which thread their way between the pillars. In fact, the general appearance is rather suggestive of a radial arrangement of the pillars than of an accommodation to astrorhizal canals. The centres of these radial systems are, moreover, not occupied by a tube or opening of any kind, but are frequently filled by a pillar. Along lines radiating from these centres the piliars are so closely set as to seem in actual contact.

Observations.—It was only after very careful consideration and the examination of numerous sections that I felt justified in establishing *S. niagarense* and *S. parallelum* as distinct species.

Different processes of mineralization are so apt to make differences which are only apparent. That the species are distinct I conclude from the following comparisons. In vertical sections there is no difficulty in following the pillars in the latter species, while in the former it seems impossible to prepare such a section. Even when *S. parallelum* is cut obliquely the considerable interspaces seen in the other species never appear. While the larger pillars of both species are nearly alike in diameter, *S. niagarense* shows smaller pillars, or smaller parts of the same pillar. The laminae are better developed and the latilaminae are wider in *S. niagarense.* In tangential sections the appearance is very similar, but the more uniform size of the pillars, their closer spacing and their more complete radial arrangement will serve to distinguish *S. parallelum.* Owing to the close resemblance of the two forms small portions of the original photographs are given to supplement the drawings.

Locality.—Drummond Island (U.S.N.M., no. 36934). The specimens belong to Dr. Rominger's collection and are labelled *Stromatocerium, n. sp.*, and *S. niagarense*, as if that author had been in some doubt as to their identity.

APPENDIX

A number of organisms have been described from the Niagara rocks and erroneously ascribed to the *Stromatoporoidea*; it seems fitting that these forms should be reviewed and the reasons for their removal from the present association pointed out.

STROMATOPORA HINDEI, *Nich.*

STROMATOPORA HINDEI, *Nich.*, Ann. and Mag. Nat. Hist., ser. 4, vol. xiii, p. 12, and p. 13, figs. 3, *a-c*, 1874.
STROMATOPORA HINDEI, *Nich.*, Rep. Pal. Prov. Ont., p. 13, figs. 1, *a-c*, 1874.
STROMATOPORA HINDEI, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 144, 1897.

As Professor Nicholson has definitely abandoned this species it may be unreservedly removed from the Stromatoporoids.

Genus—DICTYOSTROMA, *Nicholson.*

Whatever may be the zoological affinities of this genus, it is certainly represented by a well defined and interesting form. Although Nicholson has himself abandoned the view that the organism is related to the Stromatoporoids, it seems fitting to consider its general features on account of the resemblance presented to the class of fossils under review. Nicholson's original description appeared in the Palaeontology of Ohio, Volume II, 1875, at which time he was of the opinion that the genus was closely connected with *Stromatopora*. In his monograph, however, he abandons this view, as will be seen from the following quotation:—"Its precise affinities are not absolutely clear, but it is sufficient for my present purpose to point out that the genus *Dictyostroma*, Nicholson, must no longer be regarded as a member of the great series of the *Stromatoporoidea*." Dr. Rominger was also of the same opinion, for, after describing the organism, he states:—"There remains no doubt in my mind that......... the former *Dictyostroma* of Nicholson belongs to the tribe of Alveolites, Limaria, etc. I propose, therefore, for them the name of *Alveolites Stromatoporoides*."* It is manifestly unfair to Nicholson to supplant his specific name, even if the fossil in question is really an *Alveolites*. In the opinion of the writer both genus and species as established by Nicholson should stand. An amended description follows:—

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*Proc. Acad. Nat. Sci. Ph p. 55. 1886.

The corallum is made up of a confluent series of small tubes, which radiate from certain centres on a basal epitheca, continue in a horizontal direction for the greater part of their course, and then turn abruptly upward. When three to eight layers of tubes have been formed there is a cessation in growth, so that the ends of the tubules appear as points on the surface. When the activity of the organism is renewed a new epitheca appears, spread like a veil over the upturned points of the old surface: on this a new series of tubes are formed. The result of this manner of growth is that the whole corrallum presents the appearance of a series of superimposed plates with papillose surfaces (Pl. XIV, fig. 3). It is this appearance that has suggested the relationship to the Stromatoporoids. The composition of the plates from tubes makes this association impossible. The horizontal character of the individual elements and their manner of opening to the surface makes the relationship to *Alveolites* and *Limaria* almost beyond doubt. The peculiar serpentine and radial arrangement of the tubules is very like that observed in the genus *Berenicea*, Lamouroux; but the structure of the tubes themselves and their manner of emergence is not in accord with the habit of the *Bryozoa*. The only undoubted member of the genus is *Dictyostroma undulatum*, but certain forms from Michigan may possibly belong here; it is hazardous, however, to include them, as the minute structure is entirely destroyed. I was at first inclined to place under this genus the form herein described as *Alveolites thoroldensis*, in which the arrangement and character of the tubes is much the same. The difference in the manner of emergence, and the lack of the plate-like structure in the corallum, have, however, induced me to place the latter species under *Alveolites*.

DICTYOSTROMA UNDULATUM, *Nicholson*.—Plate XIV, Figs. 3 and 4; Plate XV, Figs. 3, 4, 7 and 8

DICTYOSTROMA UNDULATUM, *Nich*, Pal. of Ohio, vol. ii, p. 254, pl. xxiv, figs 6 and 6c, 1875.
DICTYOSTROMA UNDULATUM, *Nich.*, Mon. Brit. Strom., p. 85, and p. 232, 1892
ALVEOLITES STROMATOPOROIDES, *Rom.*, Proc. Acad. Nat Sci. Phil., p. 55, 1886.

The size of the corallum cannot be stated with certainty, as only fragments are available, but it must have been large, probably 25 cm. in diameter, with a vertical extent in the centre of about half that distance. The whole coral is composed of a series of layers, which, viewed macroscopically, appear as plates with a thickness of from ½ to [illegible] mm. These plates are separated by intervals about equal to their own diameter. The surface of each layer is studded with hollow spines situated about ½ mm. apart. There is no organic connection between contiguous layers, the upper one conforming to the general surface of that below, and resting on its longer spines, while the shorter ones may not reach the under surface of the superimposed layer. (Pl. XIV, fig. 3; Pl. XV, fig. [illegible].) Each plate is composed of from one to eight layers of tubes. The tubes of each layer radiate from certain points, extend horizontally, are in close apposition, and open to the surface by short upward inflections of their distal ends. The tubes are much flattened vertically, being from ½ to 1 mm. wide, with a height of only ⅙ mm. The under side of a layer shows a concentrically wrinkled appearance, the concentric wrinklings forming around the centre from which the tubes radiate. The under surface of a plate shows many of these concentric "epithecae" (?), for each system of radiating tubes does not reach a greater diameter than 10 mm., while the horizontal extent of a plate is many times greater. (Pl. XV, fig. 8.)

The tubes open to the surface in slit-like or crescentic orifices, the lips of which may or may not be prolonged upwards into hollow tubes.

Vertical sections (Pl. XV, fig. 4) show very clearly the transverse or longitudinal sections of the tubes, as the case may be. The second layer from the bottom is cut in the direction of the tubes, revealing their strict horizontal character and considerable extent. The tubes of the layer above are cut transversely, showing the width of the tubes and their close apposition. The spines are evidently the upturned ends of tubes, and it may be observed that they do not always belong to the upper layer of tubules.

Owing to the slight vertical extent of the tubules, tangential sections (Pl. XV, fig. 3) present a very much confused aspect and are rather unsatisfactory and yet quite typical.

Observations.—The zoological affinities have been already discussed. In the present paper it really suffices to point out clearly that this organism, while resembling a Stromatoporoid must be removed to some other association. What that association may be must be left to some investigator thoroughly acquainted with the *Bryozoa* and corals.*

Locality.—Louisville, Ky

ALVEOLITES THOROLDENSIS, *sp. nov.*—Plate XV, Figs. 5 and 6

The strong resemblance of this coral, particularly in vertical section, to a member of the genus *Clathrodictyon* must serve as an excuse for its consideration in the present article. The corallum forms a cake-like expansion, growing on different species of *Favosites*, and reaching a diameter of 7 or 8 cm., with a height of from 6 to 8 mm. The skeleton is made up of a series of prostrate or slightly ascending tubules which arise on certain points of the substratum or on a basal epitheca (not observed). From these points the tubules radiate outwards in a flexuous manner. New tubules appear as the increased diameter requires them, until one series of tubes meets with its neighbour. The centres of these systems are about 1½ cm. apart. the horizontal diameter of a tube is about ½ mm., and its vertical extent not more than from ⅙ to ¹/₇ mm. The upper and lower walls of contiguous tubes are coalesced so that they form continuous undulating sheets. As many layers are superimposed the whole skeleton seems to consist of a series of crenulated laminae. The tubes themselves seem to lose their significance and appear as flattened, sinuous passages between the laminae The whole corallum is not continuous throughout, but is arranged in layers which have a thickness of about 3 mm. The tubes, while prostrate at first, ascend at a gentle angle, and the last layers are still horizontal and may be seen on the surface as systems of radial tubes about certain centres, as already mentioned. It is apparent, therefore, that the openings occur only

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*Professor Bassler has since written to me as follows: "This is certainly not a bryozoan, and therefore not allied to *Berenicea*, but it appears to me to be related to certain corals, such as *Coenites Limaria*, etc. I believe Davis has figured the same form in his Kentucky Fossil Corals, as *Milleria* (n. gen.) *laminata*."

on the periphery of the whole skeleton, and towards the borders of the different radial systems.

On the surface, the radiating systems of tubes can be distinctly seen as sinuous, feathery, brush-like expansions. On the periphery, or where weathering has exposed them around elevated points, the openings of the tubules appear as slit-like orifices with crenulated lips. Owing to the coalescence of the tube walls these slits occur in rows, with both their upper and lower lips more or less continuous.

Vertical sections (Pl. XV, fig. 6) show the cut edges of the laminae and their slightly ascending character. The severed dissepiments indicate the presence of these structures, but they do not seem to be numerous. Tangential sections (Pl. XV, fig. 5) show the radiating tube walls, and, at right angles to them, the cut edges of the laminae, which appear as crenulated lines.

Observations.—The coalescence of the tube walls into pseudo-laminae gives this species a very strong resemblance to the Stromatoporoids; this feature is, however, present to a greater or less extent in other species of *Alveolites*. The cake-like character of the corallum seems to bring the species closer to *Alveolites* than to the other genera of the same association.

Locality.—Louisville, Ky., U.S.N.M., no. 41211, E. O. Ulrich, coll. Thorold, Ont., Byron E. Walker, coll. (This specimen is the more perfect and is made the holotype.)

PROTAREA WALKERI, *Spencer sp.*—Plate XV. Figs. 1 and 2

CAUNOPORA WALKERI, *Spencer*, Bull. Mus. Univ. Missouri, vol. i, no. 1, p. 46, pl. vi, figs. 9 and 9a, 1884. Advance sheets, 1882.
CAUNOPORA WALKERI, *Spencer*, Canadian Naturalist, vol. x, no. 3, p. 165, 1883.
CAUNOPORA WALKERI, *Nicholson*, Mon. Brit. Strom., p. 26, 1892.
CAUNOPORA WALKERI, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 144, July, 1896.

Professor Spencer's original description of this species is as follows:—" Parasitic incrusting other bodies (in this case *Favosites* in a hemispherical form thinning out at the margins) to a depth of two centimetres. Laminae thin and obscure, with chambers entirely filled with supplemental matter, only occasionally traversed by short, tortuous, horizontal canaliculi, connected with the vertical tubes. Vertical pillars connecting laminae removed or obscured by the filling, but with numerous connecting pores apparent and filled with matter differing from that of the rest of the mass.

"The organism is traversed by irregularly situated vertical tubes, producing orifices on the surface of about one-half mm. diameter, and scattered over the surface at from 2 to 4 mm. apart. In some places they seem to be surrounded by walls. The connecting pores are crowded together and are apparently situated around centres or sometimes around the larger tubes themselves, and do not exceed a tenth of a mm. in diameter. These pores extend down into the substance and sometimes appear to traverse several thicknesses of laminae, and in vertical section as many as five pores with intervening four spaces occurring in the length of one mm. The individual plates are scarcely distinguishable, as generally two or more are soldered by the supplemental filling, so that the individual laminae are not separable more than at from ½ to 2 mm. apart; but the vertical pores through this dense matter, being filled by differently coloured matter, are conspicuous through the several layers. The surface is too much worn to show any structures except when polished.

"In the specimens that I have seen, the original matter is all silicified. The specimen on which this description is based is about the fourth part of a reef, fifteen centimetres in diameter, given to the writer by Mr. A. E. Walker, of Hamilton, who obtained it from one of the lower beds of the Niagara at that city."

A fine example of this species has been presented to the University of Toronto by Dr. B. E. Walker. Like the one described by Spencer, it is about a quarter of a corallum of 15 cm. diameter, and, like it also, is incrusting on *Favosites niagarensis*. In view of the similar origin of the two specimens, it is possible that they form different parts of the same colony, or even that they are identical.

I am quite unable to agree with Spencer's interpretation of the structure of this species, and give the following new description:—Corallum incrusting on *Favosites,* reaching a diameter of 15 cm. and a height in the centre of 2 cm. The individual elements are continuous from the base to the surface, but concentric, irregular partings occur, no doubt occasioned by imperfect silicification along seasonal lines of growth, as is common in corals. These breaks are not continuous, but entirely disappear in places, showing that they have no organic significance. The specimen is entirely silicified, but cavities in the original skeleton are defined by a darker infiltered matter or by clear, crystalline silica. The corallum consists of a series of individual corallites embedded in a coenenchyma which is pierced by numerous small vertical, tabulate tubules. The larger corallites are wall-less (apparently), and have a diameter of about 1¼ mm.; their distance apart varies somewhat, but averages 1½ or 2 mm., with occasional wider separation. The tubes have a central, spongy columella, and twelve long septa which reach to the columella. They are crossed by delicate tabulae, which are about ⅕ mm. apart. No proper wall is observable, and the large corallites fade into a coenenchyma which is pierced by vertical tubules of about ⅕ mm. in diameter. These smaller tubes are likewise crossed by diaphragms having a downward curvature and situated a little closer together than in the case of the larger corallites.

Tangential sections (Pl. XV, fig. 1) show a continuous silicified matrix in which the interseptal loculi form rings of twelve almond-shaped holes pointing towards the centre. Each of these rings is seen to be surrounded by an outer irregular ring of about 15 pores. Sometimes there is room for only one of these outer rings, but when the larger tubes are wider spaced two may occur; these smaller pores represent the cross sections of the fine tubules. In the figure, the right-hand portion represents the section as it actually appears; the left-hand portion is prepared to show the probable character of the corallum before it was thickened by silicification.

Vertical sections (Pl. XV, fig. 2) exhibit the vertical tubules with their tabulae. A somewhat diversified appearance is presented by the section at those points where it cuts the larger corallites. It is manifest that the plane of section may follow the columella and contiguous septa of a tube; in this case a wide structureless band is seen. In most cases, however, the section crosses the interseptal loculi, which then appear very like the interstitial tubules.

There can be no doubt that the present example is a member of the genus *Protarea;* it is further evident that no strong difference can be observed from *Protarea vetusta*, Hall. This latter species is distinctly Ordovician in range, and in consequence it is proposed to retain Spencer's name for the Niagara type. It must not be overlooked that the writer has no certain evidence that he is dealing with a true example of Spencer's species. The type is not available, the description is uncertain, and the figures of no value. In a gross way the present example conforms very well with the description and the figures. The identity is highly probable, but cannot be stated with the finality that is desirable in such cases.

Locality.—Niagara Limestone, lower beds, Hamilton, Ont.

CERAMOPORELLA IRREGULARIS, *Bassler*.—Plate IX, Fig. 9; Plate XIV, Fig. 1

CERAMOPORELLA IRREGULARIS, *Bassler*, Bryozoan Fauna, Rochester Shale, U.S Geol. Sur. Bull. 292, p. 21, pl. ix, figs. 7-9, 1906.
Cf. DICTYOSTOMA RETICULATUM, *Spencer*, Bull. Mus. Univ. State Missouri, vol. i, no. 1, p. 51, pl. vi, figs. 14 and 14a, 1882.
Cf. DICTYOSTOMA RETICULATUM, *Spencer*, Can. Nat., vol. x, no. 3, p. 37, 1883
Cf. DICTYOSTROMA RETICULATUM, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 145, 1896.

The genus described by Nicholson as *Dictyostroma* certainly does not belong to the *Stromatoporoidea;* it is, therefore, necessary to make some investigations into the nature of the form referred by Spencer to this genus. At the outset it must be admitted that the fossil about to be described may not be an example of Spencer's species. I believe that it is, simply because no others from a large collection conform in any degree with his description. The present example however, in a gross way at least, agrees very well, as will be pointed out in the course of the description which follows.

The polyzoarium consists of a series of concentric layers which are a little more than 1 mm. apart. Each layer, viewed in the rough, is seen to be composed of a basal portion, about ½ mm. in thickness, and an upper part, generally filled with matter of a different colour, through which penetrate spines arising from the basal plate (Spencer's "concentric laminae and interlaminar spaces"). There is no organic connection between the layers, the upper one in each case growing over and conforming to the shape of that below. My only example is a fragment about 4 cm. high and has evidently been broken from a much larger piece. Like Spencer's example, it is highly silicified, and was obtained from the "cherty beds" at Hamilton, Ont.

Examined microscopically, the plate-like lower portion of each layer is seen to be composed of tubules which rise at an angle of about 30° from a very thin epithecal expansion. These tubes are from ¼ to ⅓ mm. in diameter, and when they reach the superior surface of the plate-like portion they turn abruptly upwards with a diameter of from ⅓ to ½ mm. This upper part, being more open in character, has been filled with foreign matter before the more solid basal portion. The cut edges of the upturned tubes appear as "elongated processes which extend to the lower side of the next layer. There are about three of these points in every millimetre of length." Spencer also says, "There are occasional strong vertical pillars, at every two centimetres apart, that only extend from one layer to the next. In some specimens this last laminar support is wanting." I have not observed these structures in my specimen, unless an occasional higher level reached by the vertical part of a tubule might be so interpreted.

Vertical sections (Pl. XIV, fig. 1) present an extremely varied appearance, which at once stamps the fossil as not belonging to the Stromatoporoids. In places the slanting part of the tubes is cut transversely, so that each tubule appears as a rounded or, more correctly, an arch-like aperture. In other parts, where the section follows the direction of a tube, its divided walls appear as slanting lines. Each tubule is crossed by a diaphragm at the upper level of the basal portion. This fact tends to emphasize the plate-like character of this part of the organism. Much less diversity is seen in the upper part of each layer, because the tubes are here vertical. An occasional diaphragm is seen, and some evidence of smaller tubes between the larger ones (mesopores). (This is much better shown by tangential sections.) The thin basal epitheca of each layer is seen to conform to the superior surface of that below without forming any organic connection with it.

Tangential sections (Pl. IX, fig. 9) show the polygonal cross section of the vertical tubes, each of which at the higher levels is surrounded by a ring of smaller tubules (mesopores). As the plane of section sinks lower in a layer the small tubes disappear, and finally, as the basal plate is cut, the walls of the zoecia appear as parallel lines.

Observations.—This organism does not belong to the same genus as *Dictyostroma undulatum.* The tubules are not prostrate; they are not noticeably flattened; they are not as long; and they do not open in like manner. It is sufficient for the present purpose to have proved that the organism is not a Stromatoporoid. Having determined it to belong to the *Bryozoa*, I sent the sections to Dr. Ray S. Bassler, of the United States National Museum, who has kindly identified the species. The above description is written with the main object of pointing out the differences of this organism from a Stromatoporoid. For an account of the species couched in the technical language applicable to the *Bryozoa,* see Dr. Bassler's original description (*op. cit.*).

Locality.—Dr. Bassler states the form to be rare at Rochester, N.Y. The present specimen is from Hamilton, Ont. The repeated or concentric manner of growth, which gives the form its Stromatopora-like aspect, is perhaps confined to this latter locality.

CAUNOPORA MIRABILIS, *Spencer*

CAUNOPORA MIRABILIS, *Spencer,* Bull. Mus. Univ. State Mo., Vol. I, No. 1, p. 47, pl. vi, figs. 10, 10*a*, and 10*b*, 1882

Of Dr. Spencer's species from the Niagara of Hamilton, Ont., there still remains *Caunopora mirabilis.* I have been unable to learn anything regarding the present place of keeping of the type specimen, and have nothing in my collections which conforms to Spencer's description. If, as stated, the species closely resembles *C. walkeri,* then it must be referred to the *Hexacoralla,* but without material to work with it is impossible to add anything to the original description.

EXPLANATION OF PLATES VII TO XV.

(*All figures not otherwise specified are enlarged ten times.*)

PLATE VII

Fig. 1—*Clathrodictyon vesiculosum*. Vertical section. Lake Temiskaming
Fig. 2—*Clathrodictyon variolare*. Vertical section. Manitoulin Island.
Fig. 3—*Clathrodictyon cystosum*. Vertical section. Drummond Island.
Fig. 4— " " (folded variety). Vertical section. Drummond Island.
Fig. 5— " " var. *lineatum*. Vertical section. Ann Arbor, Mich. U.S.N.M., no. 36924
Fig. 6—*Clathrodictyon vesiculosum*, var. *minutum*. Vertical section. Lake Temiskaming
Fig. 7—*Clathrodictyon drummondense*. Vertical section. Louisville, Ky
Fig. 8—*Clathrodictyon fastigiatum* in Caunopore state. Vertical section. Locality not certain.

PLATE VIII

Fig. 1—*Clathrodictyon variolare*. Vertical section. North Shore, Lake Michigan. U.S.N.M., no. 36825.
Fig. 2—*Clathrodictyon vesiculosum* (lined variety). Vertical section. Lake Temiskaming
Fig. 3—*Clathrodictyon drummondense*. Vertical section. Drummond Island. U.S.N.M., no. 36814.
Fig. 4—*Clathrodictyon vesiculosum*. Tangential section. After Nicholson.
Fig. 5— " " var. *minutum*. Tangential section Lake Temiskaming.
Fig. 6—*Clathrodictyon cystosum* (folded variety). Tangential section. Drummond Island.
Fig. 7—*Clathrodictyon drummondense*. Tangential section. Drummond Island. U.S.N.M., no. 36814.
Fig. 8—*Clathrodictyon cystosum*, var. *lineatum*. Tangential section. Ann Arbor, Mich. U.S.N.M., no. 36924.
Fig. 9—*Clathrodictyon variolare*. Surface of the natural size. Manitoulin Island.

PLATE IX

Fig. 1—*Actinostroma tenuifilatum*. Vertical section. Drummond Island U.S.N.M., no. 36828.
Fig. 2— " " Tangential section. Drummond Island.
Fig. 3— " " (coarse variety). Vertical section. Drummond Island.
Fig. 4—*Labechia delicatula*. Vertical section. Osgoode, Ind. U.S.N.M., no. 41218.
Fig. 5— " " Vertical section x 50. Osgoode, Ind.
Fig. 6— " " Tangential section. Osgoode, Ind.

Fig. 7—*Chalazodes granulatum* Surface of natural size. Drummond Island. U.S.N.M., no. 36040
Fig. 8—*Chalazodes magnum.* Surface of natural size. Manitoulin Island
Fig. 9—*Chalazodes spindicandum.* Surface of natural size. Louisville, Ky U.S.N.M., no. 36036
Fig. 10—*Ceramoporella irregularis.* Tangential section Hamilton, Ont

Plate X

Fig. 1—*Syringostroma niagarense.* Vertical section. North Shore, Lake Michigan U.S.N.M., no. 36033
Fig. 2— " " Tangential section. As above
Fig. 3—*Syringostroma parallelum* Vertical section. Drummond Island U.S.N.M., no. 36034
Fig. 4— " " Tangential section. As above
Fig. 5—*Syringostroma niagarense.* Vertical section. As above
Fig. 6—*Syringostroma parallelum.* Tangential section. As above
Fig. 7—*Syringostroma niagarense.* Tangential section. As above
Fig. 8—*Chalazodes magnum.* Vertical section. Manitoulin Island

Plate XI

Fig. 1—*Chalazodes granulatum.* Vertical section. Drummond Island U.S.N.M., no. 36040
Fig. 2— " " Tangential section. As above
Fig. 3—*Chalazodes spindicandum.* Vertical section. Louisville, Ky. U.S N.M., no. 36036
Fig. 4— " " Tangential section. As above
Fig. 5—*Chalazodes magnum.* Vertical section. Manitoulin Island
Fig. 6— " " Tangential section. Manitoulin Island
Fig. 7—*Chalazodes granulatum* Vertical section. As above
Fig. 8— " " Tangential section As above

Plate XII

Fig. 1—*Stylodictyon columnare.* Vertical section. Louisville, Ky. U.S N.M., no. 41210
Fig. 2— " " Tangential section. As above
Fig. 3—*Rosenella manitoulinensis.* Vertical section. Manitoulin Island.
Fig. 4—*Actinostroma whiteavesii*, var. *niagarense.* Vertical section. Thorold, Ont.
Fig. 5— " " var. *niagarense.* Tangential section. Thorold, Ont.
Fig. 6—*Stromatopora indianensis.* Tangential section. North Madison, Ind. U.S.N.M., no. 41216
Fig. 7—*Stromatopora hudsonica.* Tangential section. After Nicholson
Fig. 8— " " Vertical section. After Nicholson
Fig. 9—*Stromatopora indianensis.* Vertical section. As above

PLATE XIII.

Fig. 1—*Stromatopora antiqua.* Tangential section. After Nicholson.
Fig. 2— " " Vertical section x 2. After Nicholson.
Fig. 3— " " Vertical section. After Nicholson.
Fig. 4— " " Natural size. After Nicholson.
Fig. 5— " " Vertical section. Thorold, Ont.
Fig. 6— " " Vertical section. Lockport, N.Y.
Fig. 7—*Stromatopora constellata.* Vertical section. Cobbleskill, N.Y.
Fig. 8— " " " " " "
Fig. 9—*Stromatopora typica.* Tangential section. England.
Fig. 10—*Stromatopora constellata.* Tangential section. Cobbleskill, N.Y.

PLATE XIV

Fig. 1—*Ceramoporella irregularis.* Vertical section. Hamilton, Ont.
Fig. 2—*Chalazodes romingeri.* Vertical section. Ann Arbor, Mich. U.S.N.M., no. 36813.
Fig. 3—*Dictyostroma undulatum.* Vertical section (surface), natural size. Louisville, Ky. U.S.N.M., no. 37254.
Fig. 4— " " Epitheca. Natural size. As above.
Fig. 5—*Clathrodictyon rectum.* Tangential section. Louisville, Ky.
Fig. 6— " " Vertical section. Louisville, Ky.
Fig. 7— " " " " " "
Fig. 8—*Rosenella manitoulinensis.* Surface of a lamina x 5. Manitoulin.
Fig. 9—*Stromatopora hudsonica.* Vertical section. Equan river. Geol. Sur. Can.

PLATE XV

Fig. 1—*Protarea walkeri.* Tangential section. Hamilton, Ont.
Fig. 2— " " Vertical section. Hamilton, Ont.
Fig. 3—*Dictyostroma undulatum.* Tangential section. Louisville, Ky. U.S.N.M., no. 37254.
Fig. 4— " " Vertical section. As above.
Fig. 5—*Alveolites thoroldensis.* Tangential section. Thorold, Ont.
Fig. 6— " " Vertical section. Thorold, Ont.
Fig. 7—*Dictyostroma undulatum.* Superior surface. As above.
Fig. 8— " " Inferior surface (epitheca). As above.

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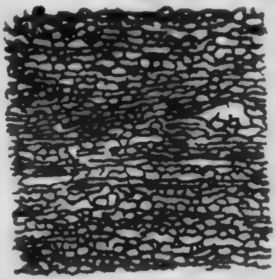
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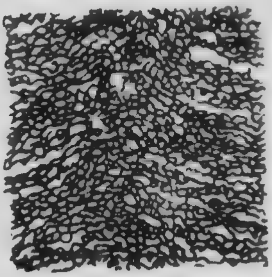
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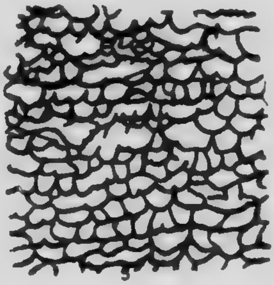
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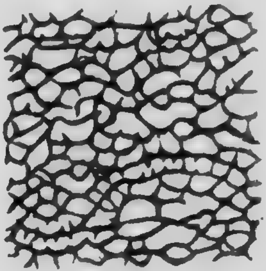
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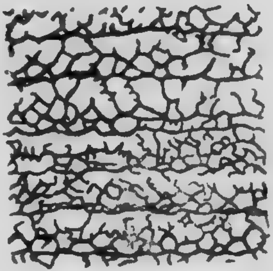
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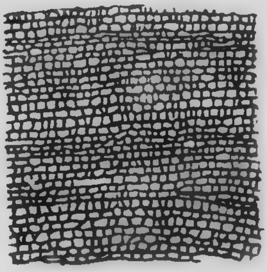
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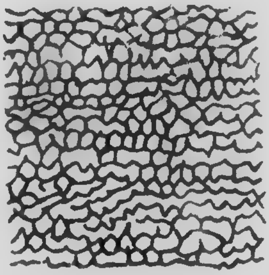

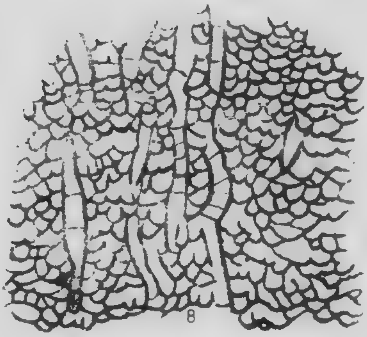
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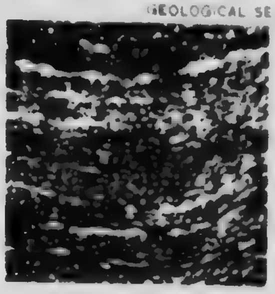
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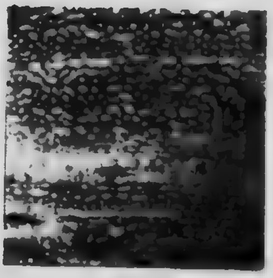
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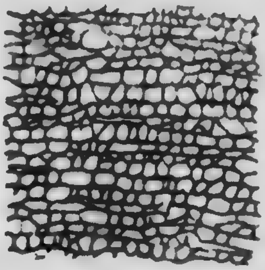
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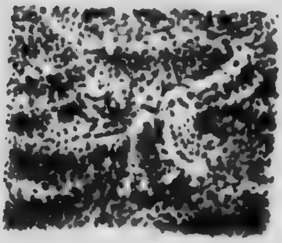
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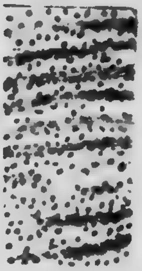
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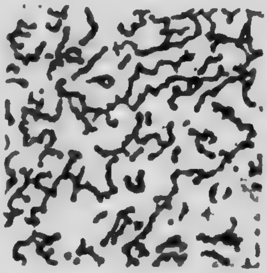
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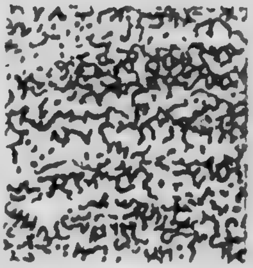
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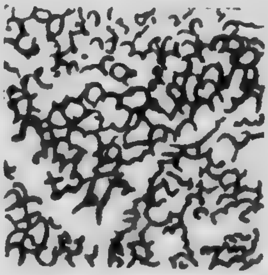
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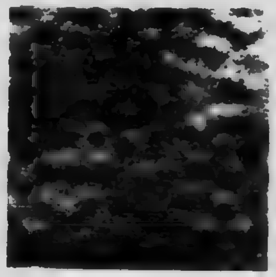
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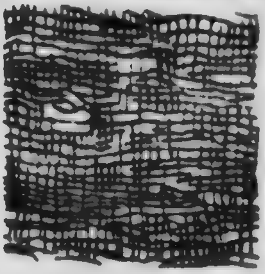

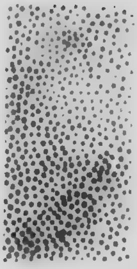

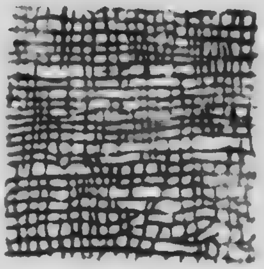

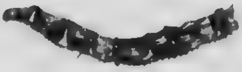

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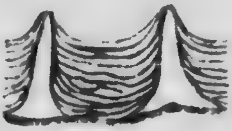

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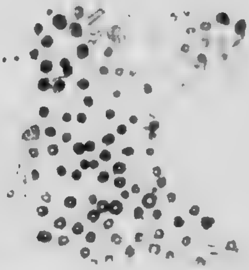

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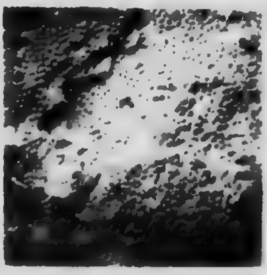

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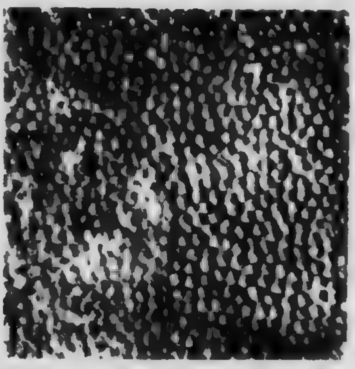

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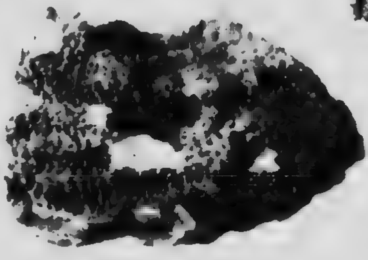

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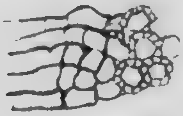

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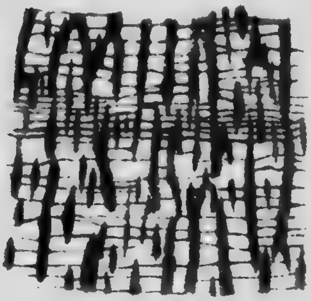

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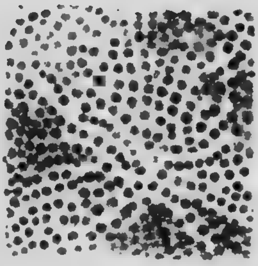

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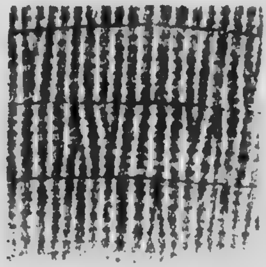

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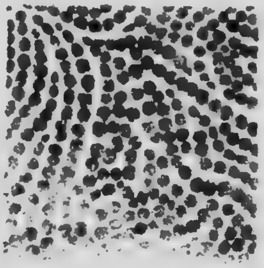

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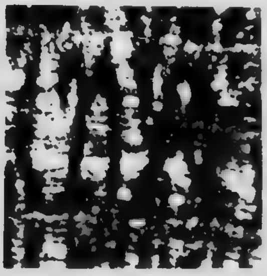

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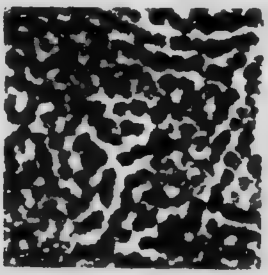

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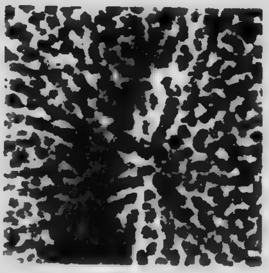

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UNIVERSITY OF TORONTO STUDIES
GEOLOGICAL SERIES NO. [illegible]

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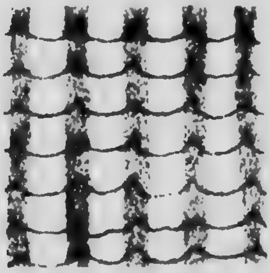

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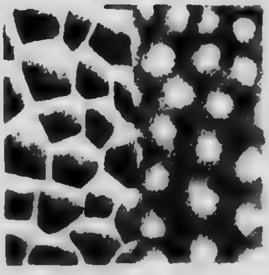

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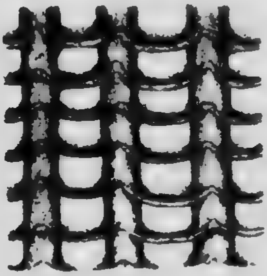

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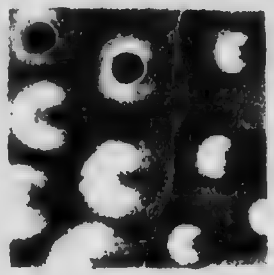

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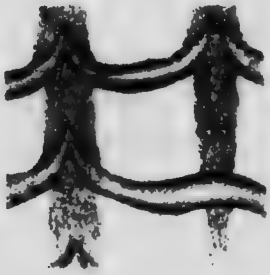

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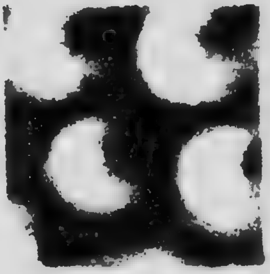

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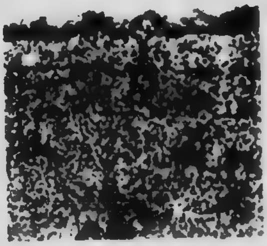

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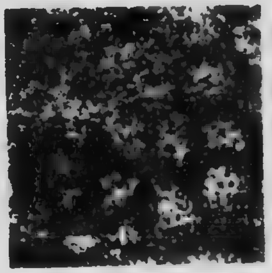

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W. A. PARKS PHOTO-MIC. AND DEL.

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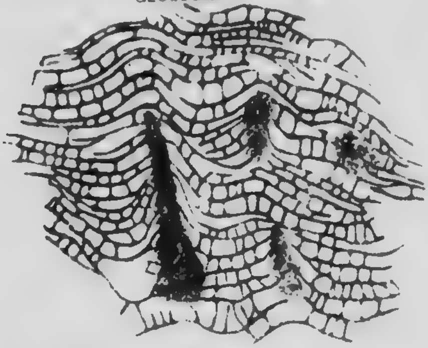

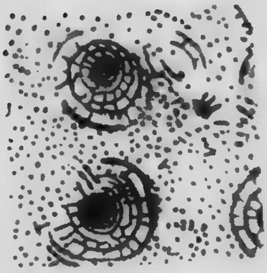

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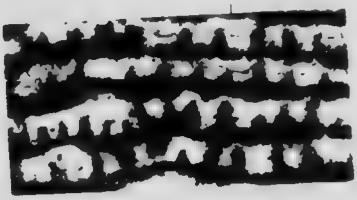

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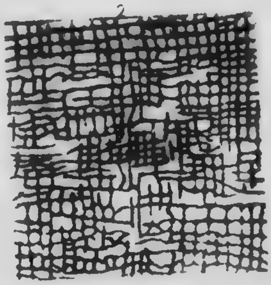

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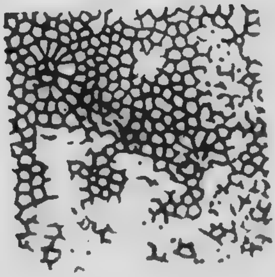

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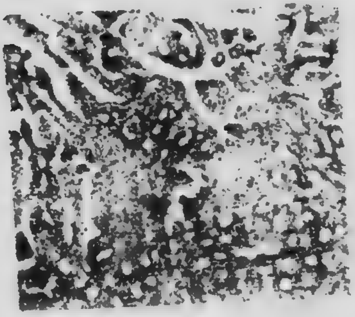

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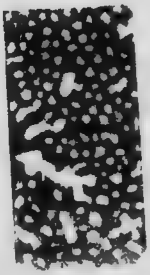

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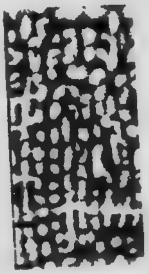

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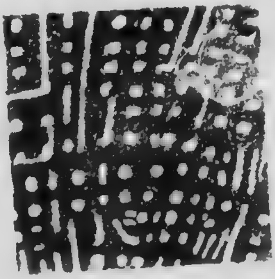

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W. A. PARKS DEL.

PLATE

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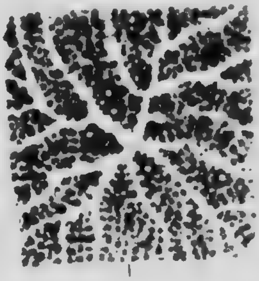
GEOLOGICAL SERIES NO 4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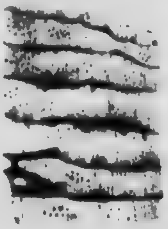
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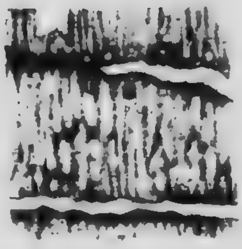
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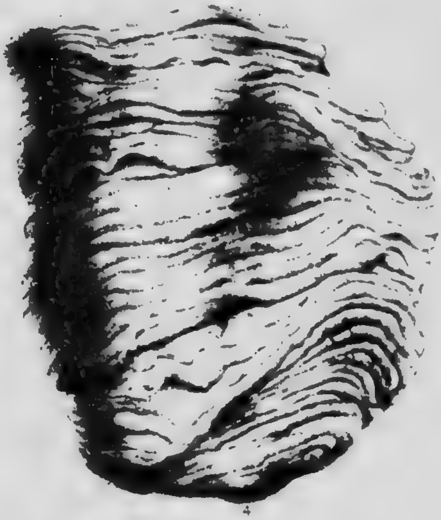
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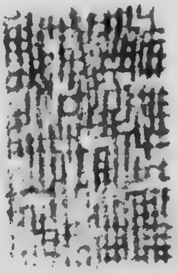
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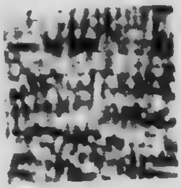
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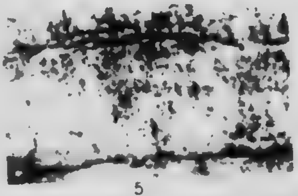
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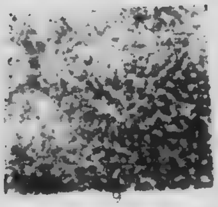
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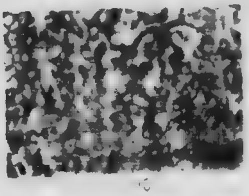
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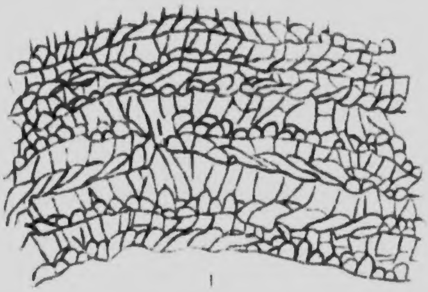
W. A. PARKS PHOTO M SC
A. J. READING PHOTO

COCKAYNE BOSTON



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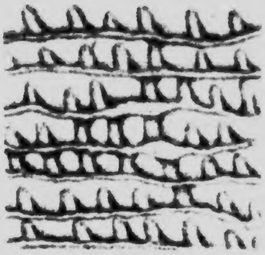

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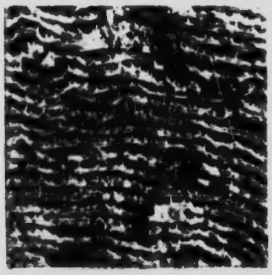

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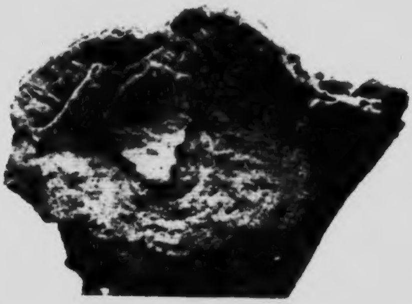

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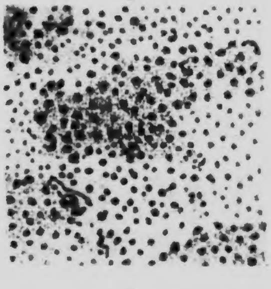

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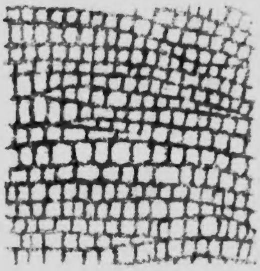

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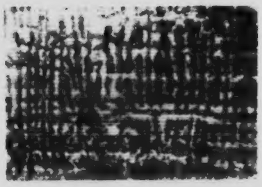

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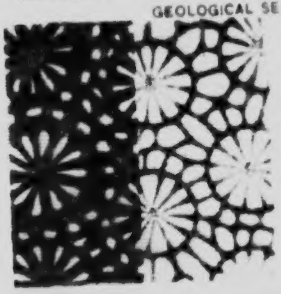
W. A. PARKS, DEL.
A. J. READING, PHOTO

COCKAYNE, BOSTON

UNIVERSITY OF TORONTO STUDIES
GEOLOGICAL SERIES NO. 5

PLATE 15.



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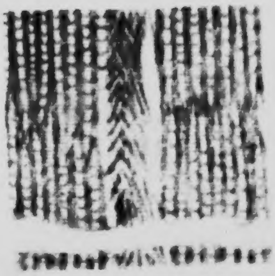

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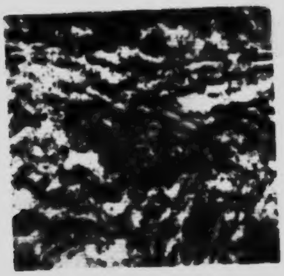

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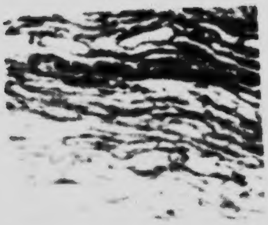

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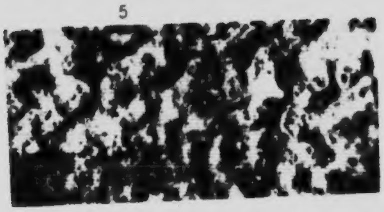

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